THE MODEL ENGINEER

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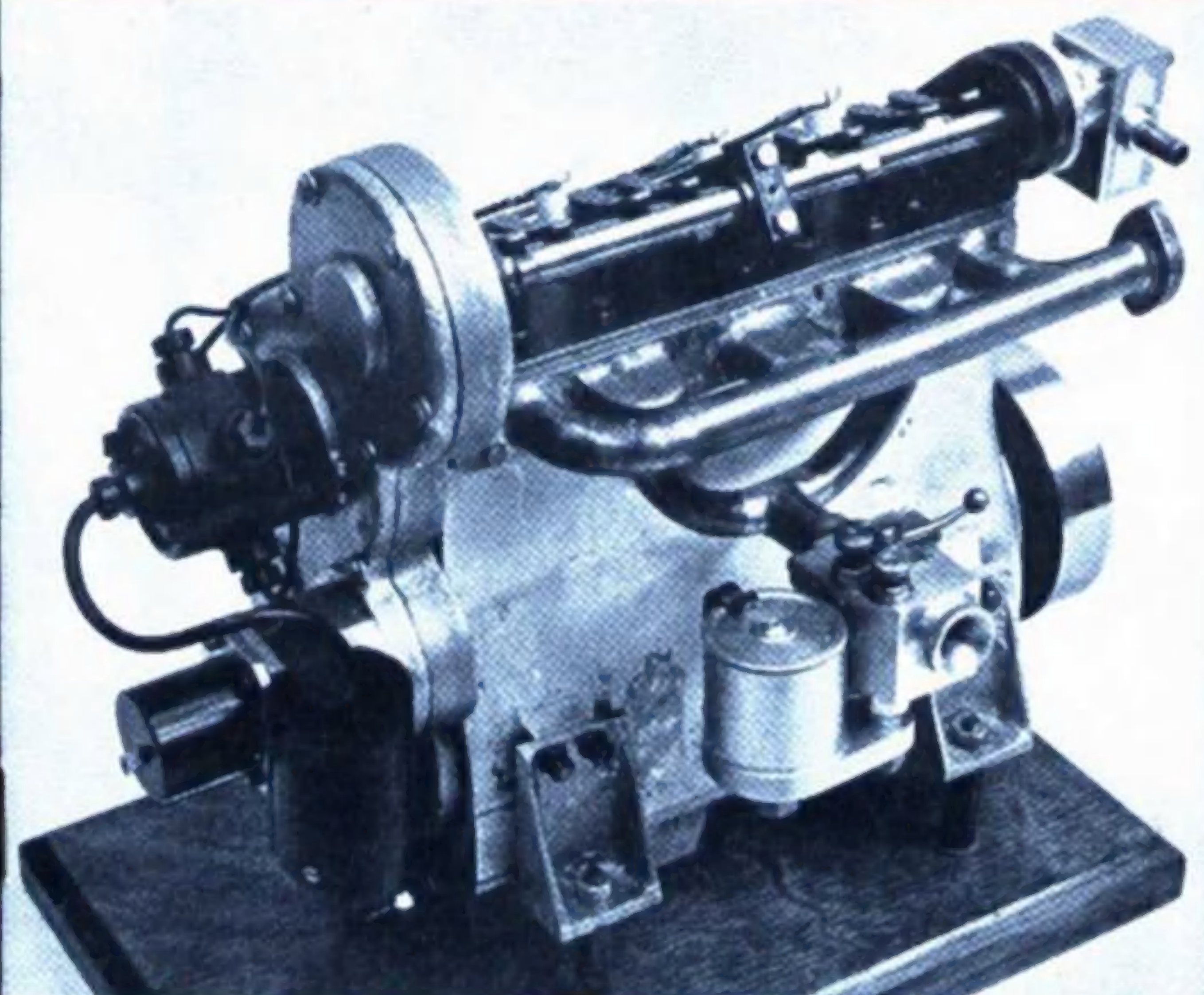

IN THIS ISSUE

- HOT-AIR ENGINE MECHANISM • QUERIES AND REPLIES
PROPELLER PATTERN CUTTING MACHINE • TWIN SISTERS
- NORTHERN MODELS EXHIBITION—WORKSHOP EQUIPMENT
ALLCHIN "M.E." TRACTION ENGINE • READERS' LETTERS

MAY 14th 1953
Vol. 108 No. 2712

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THE MODEL ENGINEER

ESTABLISHED 1898

EVERY THURSDAY

Volume 108 - No. 2712

MAY, 14th - 1953

PERCIVAL MARSHALL & CO. LTD. 19-20 NOEL STREET · LONDON · W·1

CONTENTS

Our Cover Picture

Although the majority of miniature internal combustion engines are of the single-cylinder type, and reduced to their simplest form both in design and construction, many amateur constructors are now turning their attention to more advanced types of engines. The success of the designs for twin-cylinder and multi-cylinder engines which have appeared in *THE MODEL ENGINEER*, has inspired several constructors to go still further in designs of this nature, and some very interesting—and by all accounts successful—examples have been seen at recent exhibitions. We illustrate here a four-cylinder overhead-camshaft engine of 50 c.c. capacity, constructed by Mr. A. Shaw, of the Altrincham Model Power Boat Club, and exhibited at the Northern Models Exhibition, where it won first prize in the i.c. section. This engine has a monobloc main casting, with inserted wet liners, and valves set vertically in the head, operated through rockers by an exposed camshaft which is driven by a train of spur gears from the engine crankshaft.

SMOKE RINGS

Fifty Years of London Trams

THE TRAMWAY and Light Railway Society will be staging an exhibition on the theme, "Fifty Years of L.C.C. Tramways"; it will be held at the Royal Scottish Corporation Hall, Fetter Lane, Fleet Street, London, E.C.4, on Thursday, Friday and Saturday, June 25th, 26th and 27th next. The opening times will be: 5 to 9 p.m. on the Thursday, 11 a.m. to 9 p.m. on the Friday, and 11 a.m. to 8 p.m. on the Saturday.

Many of our readers are interested in model trams, and this phase of our hobby appears to be growing with some rapidity, now that any form of tram has disappeared from the London streets! This exhibition, however, will include amongst its attractions some excellent models of trams, some of which will be seen running.

Admission will be 1s. 6d. for adults, 9d. for children, and tickets are available in advance from Mr. T. A. Gibbs, 30, Chandos Avenue, Whetstone, London, N.20.

The British Industries Fair

IN THE three sections of the Fair, at Castle Bromwich, Earls Court, and Olympia respectively, over 2,000 exhibitors were represented this year, and in view of the Coronation festivities, all sections of the Fair were brighter and more colourful than ever. This optimistic note is by no means merely superficial, for there has been a general easing of many of the problems which have beset industrialists in recent years, including restriction of raw materials, and economic difficulties in export trade. While British industries are still working under many handicaps, there is a feeling that the worst is over, and that both design and production are making rapid strides. In many cases material shortages have been met by the use of new materials, not merely makeshift substitutes, but equal in every way, and even improvements on materials originally employed.

It is, however, in the sphere of invention and improved design that British manufacturers have made the most notable progress, and an examination of the exhibits in any of the sections left little doubt that they are holding their own, to say the least, in the face of steadily increasing world competition. There were many exhibits of direct interest to model engineers, including demonstration, working or representative models of devices, including carpet looms, prefabricated buildings, industrial power equipment, etc., and in the Commonwealth section at Earls Court, the centre-piece was a scale model of the Coronation Procession Route.

Gala at Malden

THE MALDEN and District S.M.E. will be holding the usual Whitsun fete and gala at Claygate Lane, Thames Ditton, on the three days, Saturday, May 23rd, Sunday, May 24th and Monday, May 25th, commencing at 3 p.m. on the Saturday and 11 a.m. on Sunday and Monday. The exhibition will include the competition section for the Malden Medal of Merit and the Malden Championship Cup. The new headquarters building will be used for large cinema shows and the 880 ft. continuous track will be in constant operation. Admission to the fete is free, also car park, and refreshments will be available at very moderate prices.

Claygate Lane is opposite the Milk Marketing Board on the Portsmouth Road, between Kingston and Esher, and is within easy bus journeys from Kingston and other places.

The society extends a welcome to its friends from other clubs and any further information will be glady forwarded if application is made to The Hon. Social Sec., Mr. A. Doyle, 6, Bridge Way, Whitton, Middx.

HOT-AIR ENGINE MECHANISM

As embodied in the Stirling Engine

By B.C.J.

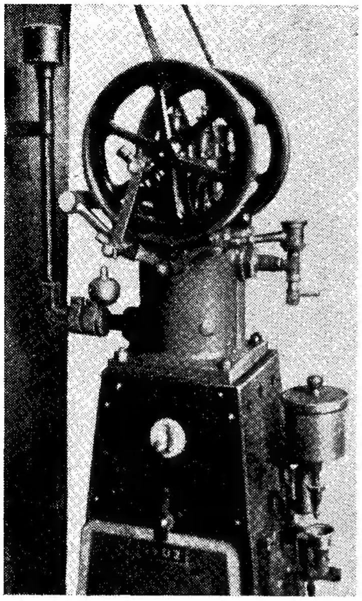


Fig. 1. Small Heinrici engine, has been in use for over 50 years

TURNING over the back pages of THE MODEL ENGINEER, one is forcibly lead to the opinion that there are still people who are interested in the hot-air engine—a class of power which was born a century or more since, and alas ! has never fulfilled the expectations of its originators.

It was to have ousted steam from the premier place—it never has. It was to have carried big ocean-going vessels across the Atlantic—it never has. It was indeed to have supplied power on a hundred and one other occasions—and *it never has.*

In the first year of a new Elizabethan age it is not indeed very much more than a toy—but a very entertaining one withal. Recently, I conceived the idea that I would explore the second-hand market in search of a toy air-engine; which I required for experimental purposes. I got into touch with several of the large London stores—but nothing had they to offer me. I fear, therefore, that the model aeroplane, the i.c. engine, and other matters have entirely usurped the interests which in former times were largely occupied by the now nearly defunct air-engine.

I would not like to affirm that this article can revive, or even partly revive, an interest in a machine that is now little more than history. Still, it seems worth while to make the attempt, for we must by no means permit the locomotive, motor-car, aeroplane and speed boat fans to occupy land, air and water; we slow-moving people must have a playground too. For my part, I think I can derive as much, or more, pleasure from watching the comparatively slow-moving links and levers of the stationary steam engine perform their several duties, as from harkening to the buzz and burr of any fast-moving machine. After all, what pleasure is there in watching the armature of a dynamo or electric motor revolve—what indeed ?

However that may be, I propose in this article to discuss the mechanism of the " Stirling " type of engine and to leave other types severely alone. This type of engine depends for its action upon the alternate heating and cooling of the same body of air transferred from one end of a chamber (hot) to the other end (cold).

Such engines are usually provided with *trunk* pistons, though, owing to the alternate pressure and evacuation within the cylinder they may be deemed *double-acting*—pressure acting upon the piston in one direction and a partial vacuum in the other.

The Heinrici Engine

Several forms of this engine were made; the mechanism of the example shown, tends to become a little complicated, since both the working piston and the displacer operate on the same axis. In the first place this introduces a forked connecting-rod and short gudgeon pins duplicated in lieu of a single pin. There is so little room at the fork ends that there is no space available for any kind of adjustment for wear; and this unfortunately seems to be the only part of the engine that wears, and is the cause of a little noise. The twin pins are too short to retain oil.

Fig. 1 is from a photograph of a small engine—which by the way, has been in my possession for 50 years and more, and still works well ! The levers referred to can be seen plainly, but Fig. 2 shows them rather more clearly. The longer of the two levers, *A*, conveys motion from the rocking shaft *B*, to the link *C*, and this link is connected to the displacer. The shorter outside lever *D*, is operated by a pin on the flywheel, and by the way there is a point to be noted hereabouts. The displacer " spindle " is, of course, hollow, and at the bottom end there is a small hole—apparently intended to release air-pressure.

Lubrication

Now in operating my engine, I had not suspected the presence of this hole and I was accustomed to drop oil down the hollow spindle with the intention of lubricating the connection (pin joint); actually, most of this oil had been passing through into the lower end of the displacer chamber—where it could be heard splashing at each stroke of the displacer. Curiously enough, this business did not appear to affect the working of the engine in any way. However, I removed the displacer, and after emptying the oil I plugged the hole—and now all is well, no more splashing. This is the kind of thing one would not suspect —but such things do occur and they may or may not be serious.

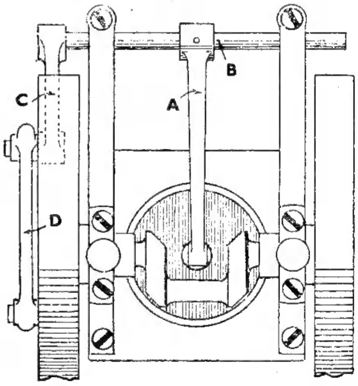


Fig. 2. Plan of Heinrici engine, showing arrangement of displacer operating levers, etc. Connecting-rod not shown

Now in regard to the proportion of the two levers. The centre one must be of such a length as to bring the rocking-shaft *B* clear of the flywheels, whilst the inner end lies approximately over the engine centre; the side lever must provide the proper amount of angular movement to

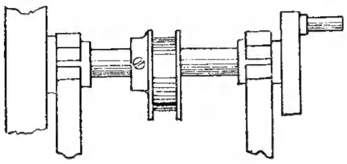


Fig. 3. Shaft arrangement of simple form of air-engine

give the correct stroke to this displacer—which matter is, of course, governed by the crankpin throw. Certainly this whole business would need to be set out on paper. Any chance scheme would be sure to lead to trouble—parts hitting where they should miss.

These links and levers, by the way, on the score of silent running, should be fitted with some adjusting device, such as that sketched in Fig. 4, which is probably as effective as any.

Referring now to the photograph of the engine, the vertical pipe on the left-hand side is nothing more than a water-filling device—one filling of the water-jacket keeps the engine comfortably cool for an hour, and does one require more? The small cylindrical chamber on

Fig. 5. Special light beam for Robinson engine

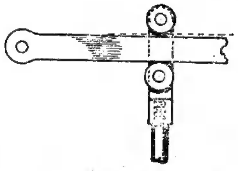


Fig. 6. Twin-roller method of driving displacer of Robinson engine from connecting-rod. (From Patent Specification)

Fig. 4. Method of adjusting knuckle joint at lever end

the right-hand side is but a fuel supply tank (meth.) and feeds spirit to the burner cup by an adjustable needle valve, and there is a wick feed to the supply which renders stoppage of the supply highly improbable.

Some years ago, when taking the engine out of store, I thought I would have a little trial run, and very unwisely, I ran the engine for perhaps twenty minutes, with a perfectly dry water-jacket—result, seizure of the hollow spindle and, of course, complete stoppage of the engine. It required several hefty blows with a hammer to drive the spindle out and a little subsequent smoothing with a file to make things comfortable; since which piece of folly, there has always been a modicum of leakage hereabouts. But the engine takes little notice, and carries on in its own sweet, safe and silent manner, providing all the power required of it—and little enough of that in all conscience.

These engines, by the way, are provided with rather a clever little adjustable braking device on the flywheel rim for checking speed when it becomes too boisterous—or for stopping the engine altogether—when for any reason that seems desirable.

I am of the opinion, that owing to the rather severe mechanical complication, none of these engines has aroused much enthusiasm among model makers, and not one has even been made other than professionally on a mass-production basis. It does not appear to me that the engine is by any means a one-off job—there are too many castings, and of course patterns to be looked after.

Simplicity Itself!

It will be well now to turn to something simpler, lest certain people be alarmed by the seeming intricacy of this hot-air business. Very well then; two bearings, a straight shaft, an eccentric, a disc crank and of course a flywheel are the main requirements of the next engine.

Fig. 3 shows these parts assembled. The disc crank is, of course, coupled to the working trunk piston, whilst the eccentric is responsible for operating the displacer, it being provided with an angular advance of 90 deg. in relation to the crankpin of the disc crank.

It will be observed that the shaft—a piece of silver-steel perchance—is a perfectly straight one, not a kink or a bend in the whole length of it. Some would prefer a crank of some sort as causing less friction than an eccentric, but I think that there is not much in this, having in view the small weight and degree of movement which falls to the lot of the eccentric. Let it be an eccentric, then, with the usual strap arranged how you will. I incline to the opinion that an eccentric with one removable flange is the best proposition, but a split eccentric strap is certainly permissible. It would generally be necessary to use a pedestal form of bearing, in order to provide good length for connecting- and eccentric-rods. Some form of "A" frame, likely enough. For convenience in erecting and taking adrift, a split bearing seem advisable though not essential.

It would be possible to say something here regarding the displacer and its chamber. But since this article purports to deal with mechanism only, I shall be glad to shelve the whole matter and get on with something more to the point, something touching the vital mechanism of the engine. I do not say that the displacer is *not* vital—by no means. A lengthy sermon could be delivered dealing with naught but *displacers*, but this is not the place for it.

The Robinson Engine

The linkage of the Robinson engine is really very sound, simple

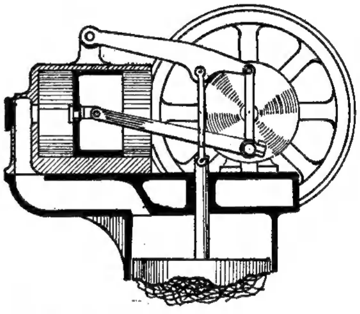


Fig. 7. Robinson engine. 4½ in. cyl. dia. $\times$ 4 in. stroke. (Section.) Note regenerator opened out to show wire entanglement

and satisfactory, for if correctly designed, there need be hardly any side thrust upon the displacer spindle—which rises and falls with a steady even motion which is a pleasure to watch.

Fig. 7 is a general view of the Robinson engine. Neither the flywheel nor the connecting-rod is that originally supplied with the engine. The flywheel, so I have been informed, at one time formed part of a spinning jenny—but now it revolves but slowly. And as for the robust circular section connecting-rod, this was made specially but without much forethought for the engine. Having fallen from favour, it has now been removed and replaced by a very light flat section rod, the original one, which looks as if it might well double-up under load, but so far never has. Both

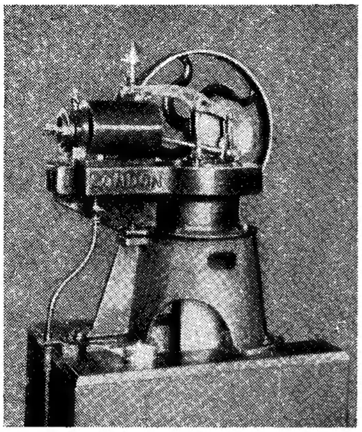


Fig. 8. A Robinson engine in author's workshop

ends of this rod, and certain other links, are provided with an excellent means of taking up wear—see Fig. 4. One boss of the lever has a screw-cut, and a cheesehead screw passes through this so as to close it up or open it out as required. Correct adjustment causes neither noise nor any tendency to seize.

Now in regard to the linkage. The stroke of the piston is 4 in., and the stroke of the displacer is 3 in., and the beam must be so proportioned as to give these dimensions : this means the division of the beam into *three* parts, the displacer pin being situated one-third of the beam length from the outer end. The beam of my engine has undergone a good deal of hand work, resulting in a shapely contour, and certain perforations which provide an appearance of lightness—see Fig. 5.

These engines, by the way, have a much better appearance when fitted with a disc crank than with any other form of crank—balanced or otherwise.

The Robinson was, in the early days, made, I think, in four sizes, the largest having a cylinder diameter of 10 in., and provided, I believe, something like $\frac{5}{8}$ h.p., and this at probably not more than 120 r.p.m.

The short vertical links do not call for much comment, except to remark that they are of rectangular section and that the crankpin end of the outer link, owing to the wear expected, would need to be provided with the form of adjustment shown in Fig. 4. I remember many years back paying a visit to the Patent Office to have a look at the Robinson patent, and amongst other mechanisms, there was one in which two rollers embraced the connecting-rod in such a way that vertical motion of the rod was imparted to the displacer rod—see Fig. 6. This seemed a simple enough device, until it is realised that the rollers would need to clear the rod sufficiently to allow for the angular position thereof at certain positions. This clearance would, of course, give rise to a great deal of noise due to a slack fit and the inertia of the displacer—a very heavy item, mark you. Owing to certain slack pins I have experienced similar trouble with my own engine, and beyond some definite speed the noise becomes alarming. Then it becomes desirable to open a cylinder relief cock, which quickly checks the speed—and the noise. Some time ago. I made an attempt to put this under governor control, but the device was not successful.

I cannot recall more than two cases in which the Robinson system of linkage has been brought into use in the amateur workshop. One a small and rather unimportant engine and the other an engine of considerable interest described by Mr. Mark Wyer in the pages of THE MODEL ENGINEER of February 22nd, 1951. The design is, in my opinion, a little elaborate compared with the "cast in one piece" (almost) of the Robinson engine. But considerable ingenuity is evident. I must confess that I prefer the simple cylindrical displacer of Mr. Wyer fitting rather closely into its casing, to the copper wire entanglement of the Robinson engine. I may be in error, but I am inclined to the opinion that the "displacer" pure and simple can give points to the "regenerator." The latter has practically no displacing value, be it noted.

I am unable to hazard a guess as to why the designer chose aluminium for the flywheel material—surely cast-iron would have been more suitable ? I do not much approve of the square section flue or chimney —I think a cylindrical chimney of suitable height and diameter would have suited the engine—though not a steam engine—better.

Miscellaneous Mechanisms

I can recall but few other kinds of mechanism applied to the operation of the displacer of the hot-air engine. The system of linkage applied to the horizontal Bailey engine really differed but little from that employed on the Heinrici engine. I must confess that I am in favour of a system that would provide *delayed* action at approximately half-stroke positions of the displacer—descending and ascending. Unfortunately, I am not able to put forward any very practical proposal for effecting this. Some years back, certain moderate-size engines were put on the market. These were fitted with fans on the crankshaft and were employed in hot countries to cause a cooling draught for the benefit of hot-raced —and perhaps hot-headed—people. I do not remember that these engines were remarkable with regard to their mechanism, however.

Concluding Remarks

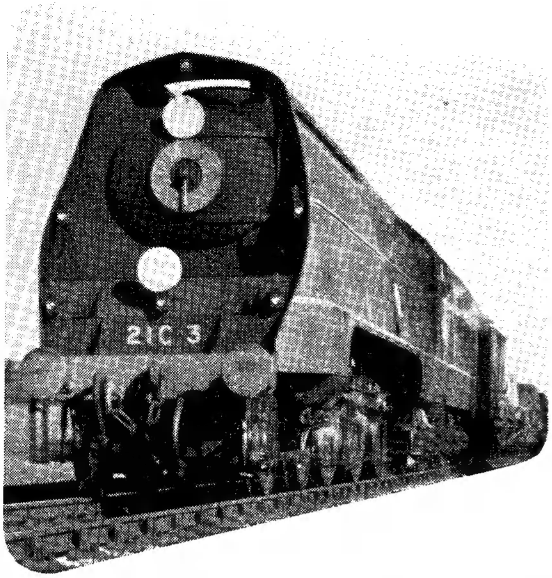
I am unaware as to whether, at the present time, any serious attempts are being made to improve the hot-air engine, either in regard to its heat-cycle or its mechanism. One seems to have heard nothing of the scheme which was the cause of some excitement in Holland some years back. Perhaps it was based on a fallacy. Or perhaps it is being developed behind an "iron curtain."

Even if the power side of the question does not lend itself to further development, the hor-air engine principle is of so much interest that it must not be allowed to die. We must, some of us, get our brains to work, study the history of these engines, and between us develop a new type of engine—more efficient, more powerful and, therefore, more interesting than anything that has gone before. A worthy task indeed, for the modern Elizabethan !

FOR THE BOOKSHELF

The British Journal Photographic Almanac, 1953. (London : Henry Greenwood & Co. Ltd.) 608 pages, 5 in. × $7\frac{1}{2}$ in., 32-page photogravure supplement. Price 5s. (board covers), 7s. 6d. (cloth bound).

This popular reference book, now in its ninety-fourth year of publication, presents, as usual, the most up-to-date information on photographic processes and equipment, together with articles by accepted authorities on various aspects of photographic art and technique. Subjects such as the electronic flash, colour photography, and sub-standard cine-photography, and a selection of recent patents are also included. In addition to numerous illustrations in the text, the art supplement contains excellent reproductions of some of the most notable photographs of the past year.



Are we in a rut?

Comments upon certain criticisms which are often levelled at model engineers

The modern touch, as expressed in a British Railways Southern Region 4-6-2 *express engine*

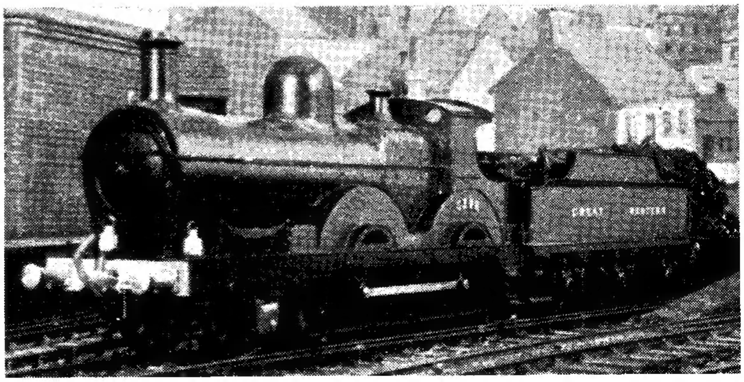
MODEL engineers are sometimes sharply criticised for, as the critics are so fond of putting it, "living in the past," or "being in a rut," just because most of the models that are built follow prototypes that are obsolete, or obsolescent. To mention some of the models that seem to annoy the critics, there are old-time locomotives, traction engines, paddle steamers, sailing ships, old types of motor-cars and the various forms of stationary steam engines ; recently, there has been a rapid increase in the numbers of models of electric tramcars, presumably because the prototypes have become obsolescent and are rapidly disappearing from the streets of our big cities ! At the Model Railway Exhibition last Easter, not only were there more working models of tramcars than ever before, but the great majority of the 3,000, or so, railway models on view reflected the pre-nationalisation and pre-grouping periods of railway history.

Is it true to say that this merely indicates a desire to "live in the past"? Are the builders of such models *really* "in a rut"? We can only assume that the critics have not taken the trouble to consider the reasons why at the present time, the tendencies they deplore should be so marked. One point that is overlooked is that a rapidly growing number of the builders of "old-time" models are men and women who are young enough *never to have seen* the prototypes. To some people, this may seem strange, but it is true; to the model maker who takes his hobby seriously it is *not* strange, but it is true, nevertheless. Moreover, it is likely to remain true for just so long as model making continues to be a hobby, and that *should* point its own moral. However, what is the explanation ?

There are several answers to that question. First, there is the fact that old-time prototypes are less bulky than their modern counterparts, and models of them are similarly less bulky, which is a great advantage when storage space, lifting and transport are considered. Secondly, there is the fact that old-time prototypes were generally more attractive, due to the neatness and simplicity of design and outline, or, in the case of stationary engines, their mechanism was so fascinating to watch when working. Thirdly, there is the fact that the production of successful working models of old-time prototypes requires considerable ingenuity in order to avoid the difficulties and disappointments that arise from reducing dimensions to scale. There are many physical, mechanical and constructional problems that have to be solved, and the true model engineer has often proved himself to be well nigh a genius in solving them.

Besides all this, old-time prototypes are attractive to the model engineer by reason of their almost endless variety, and this applies to practically any form of prototype. Consider the pre-grouping railways as an example; each had its own particular characteristics; their locomotives were immediately recognisable because of the individualistic styles of their designers, and each of these styles appealed to a large and isolated group of enthusiasts. They still do and will continue to do so. The steam locomotive, more than any other mechanical device invented by man, has always had a personality and fascination of its own, which is clearly reflected in scale models. Variety is the spice of life !

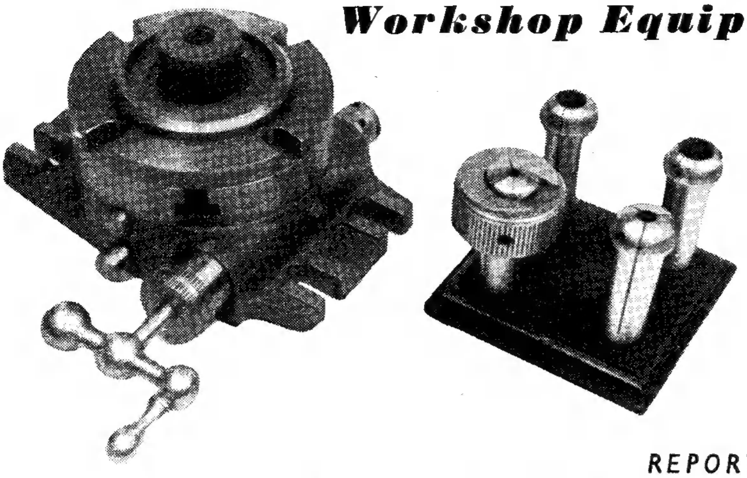
Model engineers are mostly amateurs and should be free to choose any subject they fancy; if the results are satisfactory and achieve the objects intended, this is not a matter for criticism, but rather the reverse. Ancient and modern prototypes are there to be chosen, and if the choice of one predominates over the other, what matters ?



Old-time neatness and simplicity reproduced in a model G.W.R. 2-4-0 *express passenger engine*

Workshop Equipment at the

NORTHERN MODELS EXHIBITION



REPORTED BY "NORTHERNER"

Boring table and collet set which helped to win the premier award for E. Younghusband

IN my preliminary report on the N.A.M.E. Exhibition, it was mentioned that the "Harper" Trophy, premier award in the tools section, was awarded to E. Younghusband, of Swinton, and a photograph was given of his dividing-head. Now, here are two more photographs of some of his "home-made" equipment—a rotary milling-table and a collet set, a useful angle-block and a slotted table with an angle-plate. Note that the latter has a key to ensure correct lining-up with the tee-slot.

A Useful Hand Shaper

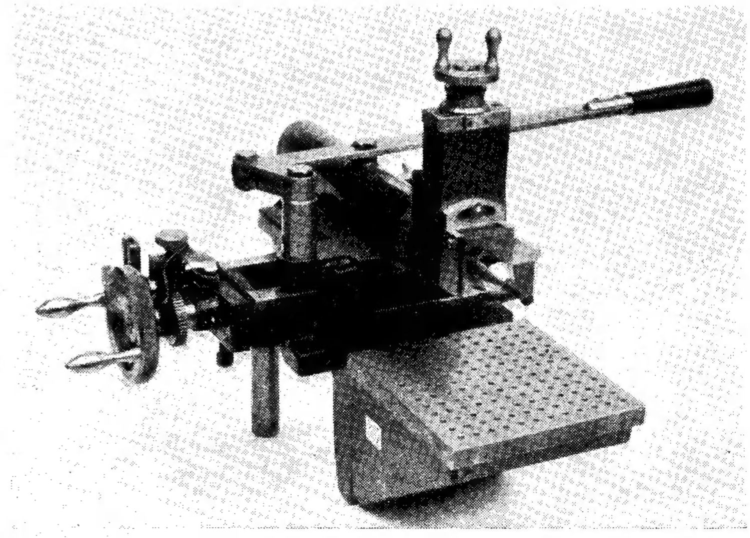
The second prize in this section was awarded to T. Schofield, of Liverpool, for his hand shaper This very useful machine was built on what might be termed conventional lines, except that instead of the work-table being slotted for holding-down bolts, it was drilled and tapped $\frac{3}{16}$ in. at $\frac{1}{2}$ in. centres. This could be a very useful feature, but one feels that $\frac{1}{4}$ in. or $\frac{5}{16}$ in. tapping (even at somewhat increased centres) would be better design, having regard to the shearing stress on the screws holding down any workpiece. A ratchet-type cross-feed was fitted, and this was self-acting and variable. Finish was good both in paintwork and machining.

Another neat and useful tool was the drilling-machine which was awarded third prize built and entered by H. Farr, of Warrington. As will be seen, the head incorporated the motor-platform, with adjustment for belt-tension, and the switch was built-in, close to the operating capstan. A useful feature was a collar clamped to the column below the head, as well as a clamp in the head itself: and the table could be tilted, raised or lowered, or swung out of the way.

"Conventional"

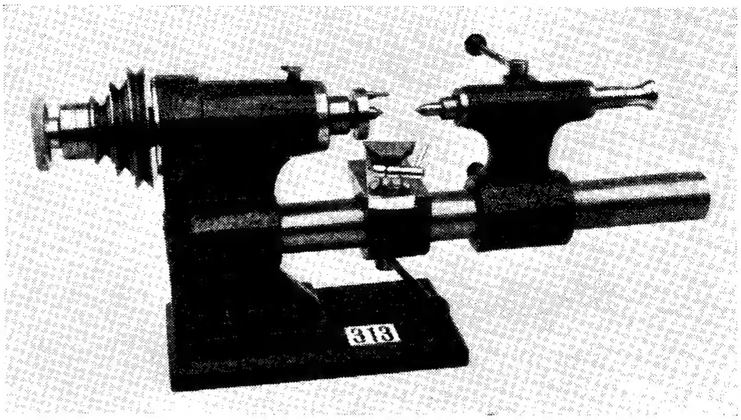
The instrument lathe entered by E. Hinchliffe, of Rochdale, was another machine of more or less conventional design—a term which is not derogatory in any way, of course. "Conventional" design is very often the one which experience has proved to be very good! In this little lathe, the machining, fitting and paintwork were all good.

Fred Haynes, whom we have previously noticed as builder of the Massey steam hammer, has added an Adept No. 2 hand shaper to his workshop during the last twelve months. However, he has not been content to leave this to hand power, but has added a neat motorising unit which, unfortunately I did not photograph. A massive casting bolted to the bedplate supports the reduction-gear from the motor, and a crank of variable centres enables



T. Schofield was awarded second prize for this substantially-built hand-shaper

the stroke to be altered. Automatic feed has also been added. At the exhibition, the machine, on loan, was shown in action, shaping gear teeth.



A well-finished instrument lathe built by E. Hinchliffe, of Rochdale

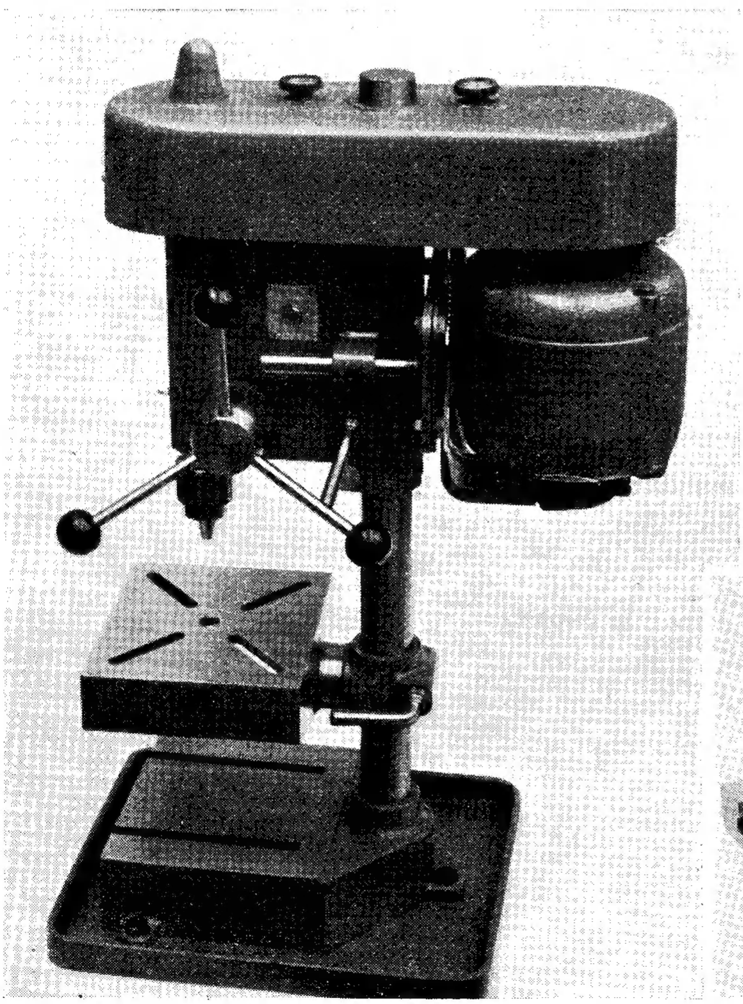
Accessories

Some neat lathe accessories were on view, made by various people, of whom N. Kettle, of Ashton-under-Lyne was one. His fabricated fixed steady for the M.L.7 lathe possessed an unusual feature, in that ball-races were fitted at the ends of the three radial arms. It would be interesting to know how this idea works out in practice.

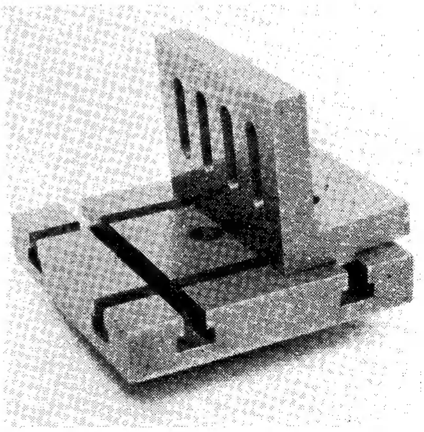
Mr. Kettle's leadscrew hand wheel was also of interest. Fitted with an indexing collar, it had a locking-device, apparently cam-operated, to allow it to be set to zero. This exhibitor also had built an example of the screw-cutting gearbox designed by Lawrence H. Sparey for the M.L.7 lathe. I only had a cursory glance at this, but it appeared to be of the same good standard of workmanship as the rest of Mr. Kettle's work.

In general, it can be said fairly that the tools and workshop equipment at the Northern show were of a high standard altogether. There was none of that "super" finish which sometimes spoils an otherwise good tool; the exhibits all wore that appearance which denotes a tool built for good, solid, honest-to-goodness work!

There seems to be quite a revival of interest in amateur tool-making; we have noted it in other exhibitions, and it may be due, partly, to the exigencies of conditions causing some tools to be cheaper to make than to buy.



An example of good craftsmanship was this drilling machine buil by H. Farr, of Warrington



Another example of Mr. Younghusband's excellent work

L.B.S.C.'s "Britannia" in $3\frac{1}{2}$ in. Gauge

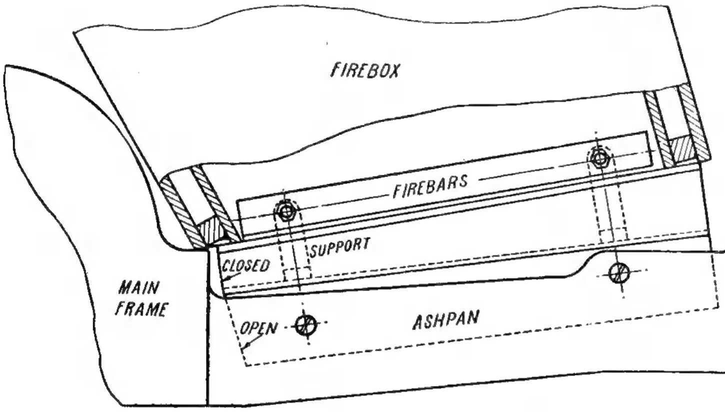
●CONSTRUCTING THE GRATE AND ASHPAN

NOW we come to the part that provides the "therms." It is quite probable that our approved advertisers will supply cast-iron grates—I hope to goodness they do! —and in that case, the overall dmensions will tally with those shown for the built-up one. The cast grate will have to be in three pieces, as the centre section must drop into the ashpan for cleaning-out purposes. The two outer sections will consist of six bars each, and the middle one seven bars; cast bars need not be so deep as the "cut" bars shown, and they will be tapered for a double purpose, viz., ease of drawing the pattern from the mould, and to let anything which can squeeze between the top edges, fall readily into the ashpan, thus maintaining a clean and free-steaming fire. There will be a small solid piece cast between the bars at each end, to hold them together; drill right through this with a No. 30 drill at one end only. Cut a piece of $\frac{1}{8}$ in. round steel, to $4\frac{7}{8}$ in. length, and put a few threads on each end. Thread the three sections of grate on it, with a $\frac{1}{8}$ in. spacer washer between each section, and put a nut on each end, leaving the nuts slack enough to allow the middle section to move freely between the outer sections. Burr over the ends of the threads, to prevent the nuts coming off. Bend up four Z-brackets, as shown, from $\frac{1}{8}$ in. $\times \frac{1}{4}$ in. steel strip, and attach them to the underside of the solid part of the grate, by $\frac{1}{8}$-in. or 5-B.A. screws. The front ones should be $\frac{1}{2}$ in. from top to bottom, and the back ones $\frac{5}{8}$ in.

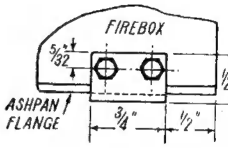
The built-up grate needs nineteen bars, each $4\frac{1}{4}$ in. long, $\frac{3}{8}$ in. deep and $\frac{1}{8}$ in. thick. Drill a No. 30 hole $\frac{1}{2}$ in. from each end of one of them, and use it as a jig to drill the rest. The spacers are $\frac{1}{8}$ in. slices parted off a piece of $\frac{1}{4}$ in. round steel rod, centred and drilled No. 30. Drill down deep enough for about three spacers at a time, or else the drill may wander, and presently you'll be parting off wee eccentric sheaves instead of spacers. Make four L-brackets as shown, from $\frac{1}{8}$ in. $\times \frac{1}{4}$ in. steel strip, and drill the upper ends with a No. 30 drill. Make a long bearer from $\frac{1}{8}$ in. steel, as mentioned above; put a nut on one end, and thread bars and spacers on it alternately; don't forget to insert a bracket instead of a spacer at the places shown in the plan view, third space from each end, with the feet pointing inwards. The shorter brackets go at the front.

Now cut a piece of $\frac{1}{8}$-in. round steel or iron wire (says Bro. Alexander!) about $1\frac{7}{8}$ in. long, and knock up a rivet head on one end of it. Swing the seven middle bars clear of the rest, and put the $\frac{1}{8}$ in. rod through the lot, with spacers between the bars; rivet over the ends, so that the whole block is tightly gripped, as shown in the illustration. Cut two more pieces, each $1\frac{5}{8}$ in. long; form a rivet head on one end, and screw the other. Poke these through the end sections, starting from the inner end, putting spacers between the outer bars, and the longer L-brackets, feet inward, right in the middle. Put nuts on the outside, screw up tightly, and burr over the threads. The centre part should swing easily between the two outer sections; "easily" is the right word, for the grate naturally expands when the fire is alight, and unless it is easy to start with, the middle section will jam up, and won't dump. Another selection of terms will then be added to the dictionary of railroad Esperanto.

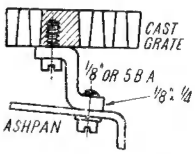
It so happens that I made the ashpan for my own engine only two evenings ago, time of writing, so I know it is the right size and will fit. Incidentally, I passed a silent vote of thanks to Bro. Diacro, far away in Lake City, Minnesota; for the way the Diacro bending brake formed that ashpan in two wags of a dog's tail, was just



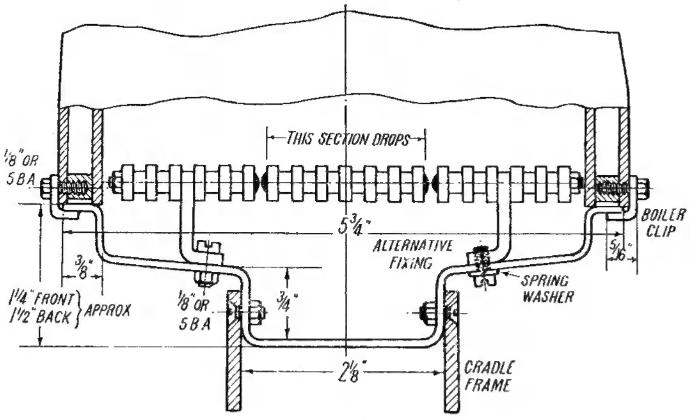
How to erect grate and ashpan



Boiler clip



Bracket for cast grate



Back view of grate and ashpan

the present case, as the ashpan slopes down towards the front, this wouldn't do, as the front would become choked in a short time; so a compromise is effected by partially closing the front, and leaving the end of the well open. Cut out a strip of 16-gauge steel that will fit nicely between the sides of the ashpan above the well, and braze it in with brass wire (I Sifbronzed mine) or alternatively, leave a tag at each end, bend it at right-angles, and rivet it to the ashpan sides. Put the completed ashpan in position in the cradle, and stand the grate temporarily on it, in the position shown. We can't permanently fix it until the boiler is ready for erection; and for that we need the smokebox saddle.

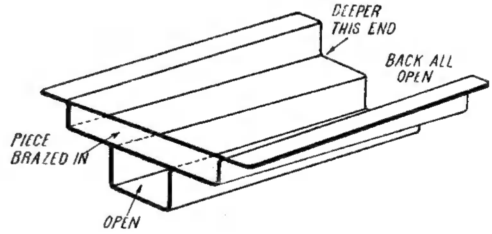
nobody's business! The job can however, be easily done by aid of the bench vice and "common savvy." Mark out a piece of 16-gauge soft mild-steel sheet as shown; scribe the bending lines pretty deeply, and start operations by bending up both sides of the well. If you bend on the 2 in. lines, the metal being $\frac{1}{16}$ in. thick, the width over the outside will be $2\frac{1}{8}$ in., and that should fit nicely between the sides of the trailing cradle. Mine did! Now, if you put a piece of bar 2 in. wide, or two bits 1 in. wide (or any combination totting up to 2 in. overall) in the well, it can be gripped in the bench vice with the next two bending lines level with the tops of the vice jaws. Knock the projecting part outwards and downwards, until flat on top of the jaws, and there is your ashpan "in embryo." Next, grip each of the projecting "wings" in the jaws, with the next bending line level with them, and you'll see immediately how the bend is made, without need of explanation; ditto repeato on the last bending line at each side, and Bob's your uncle once more.

I usually specify the ashpan to be open at the back only, and closed in front; this not only ensures an even-burning fire, but helps to keep ashes and grit off the "works." In

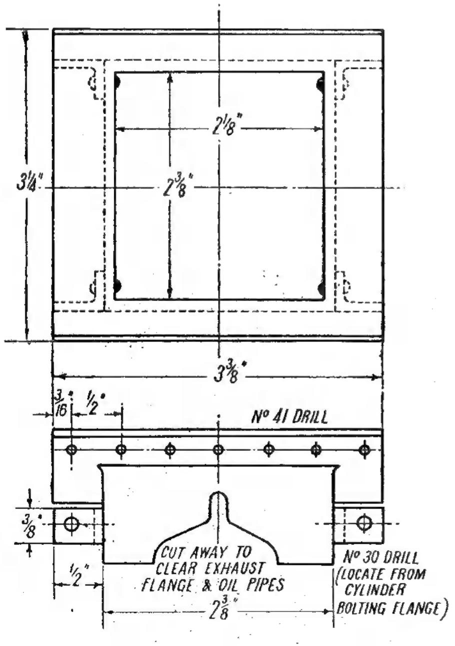
Smokebox Saddle

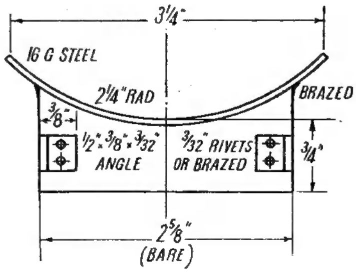
This can be cast or built up. I don't know whether our advertisers will cast the fixing lugs integral with it; probably they will. Anyway, all it needs will be a clean up with a file, and the screwholes drilled. It should be a fairly tight fit between the frames above the cylinders. Note that clearances must be filed at each side, for the exhaust flanges and oil pipes. If no lugs are cast on, pieces of angle must be attached, as shown for the built-up job.

The easiest way to make a built-up saddle, is to form both sides and end in one piece, and braze a



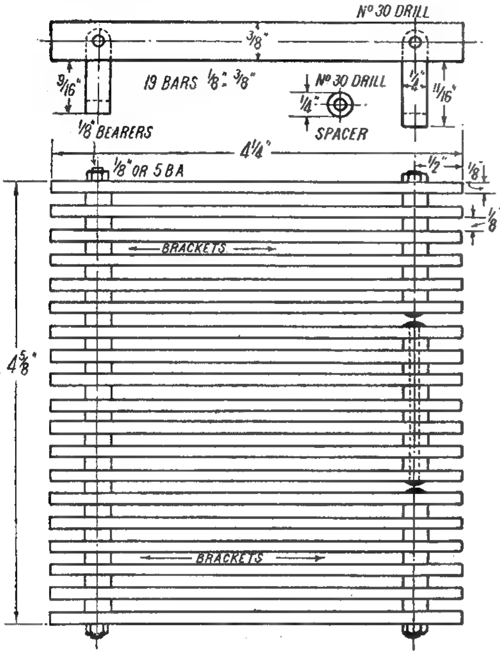
How to bend the ashpan





Left—Details of smokebox saddle

flange on it. The whole issue can be made from 16-gauge soft steel. The sides and ends will need a strip 10 in. long and $1\frac{1}{8}$ in. wide. Item No. 1 is to mark out on this, first an end, then a side, and ditto repeato. Cut out the two radii at the top of the sections that will form the ends; a job my Driver jigsaw just enjoys, but an Abrafile,



Built-up grate

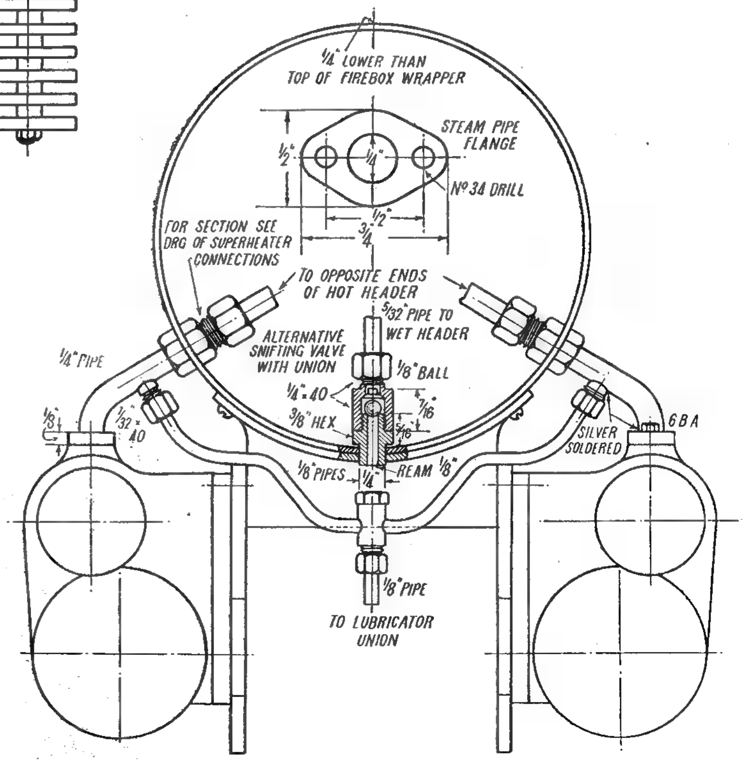
or spiral-tooth file will do it nearly as quickly by hand. If a coping saw (glorified fretsaw, is used, it needs a fine-toothed blade. Now bend the piece into a rectangle, and tie a bit of iron binding wire around it, so that the corner doesn't spring open; then cut out the top. This requires a piece of 16-gauge steel measuring $3\frac{5}{8}$ in. × $3\frac{3}{8}$ in. Cut out the middle, leaving a rectangular hole approximately $2\frac{3}{8}$ in. × $2\frac{1}{8}$ in. (see plan) and bend it to the radius of the smokebox. Put it on top of the other part, tie in position with iron binding wire, and braze it, doing the corner at the same heat.

In passing, these oddments are not the least trouble to braze; it is in fact, easier than soft-soldering. In the job just mentioned, the saddle is laid, flange downward, in a small pan of coke or breeze. Lay a fillet of flux (Boron compo, or powdered borax mised to a paste with water) all around the joint. Heat the lot to bright red, with a blowlamp, or an air-gas blowpipe, and apply a bit of thin soft brass wire to the joint. It will melt and run in, leaving a little fillet all around. Put a bit in the corner as well; let cool to black, quench in cold water, knock off any burnt flux, and that is all there is to it. No fuss, trouble, nor anything to fret about!

The little bits of angle can then be riveted on. Commercial brass angle may be used, or the angle bent up from $\frac{3}{8}$ in. strips of 3/32 in. steel; if the latter, they could be attached by a single $\frac{1}{16}$-in. iron rivet, when the rectangular part of the saddle was first bent to shape, and brazed at the same heat, when fixing the flange and the corner. The angles could be either riveted or screwed to a cast saddle, in the event of fixing lugs not being cast on. The final job is to file out the clearances for the exhaust flanges and oil pipes, as shown in the side view. The completed saddle sits between the frames, exactly opposite the bolting flanges of the cylinders, the two top bolts being removed from each side; final adjustment for height is made when erecting the boiler.

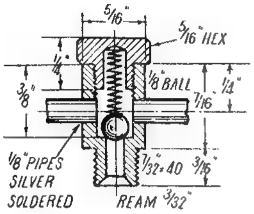
How to Erect the Boiler

The first job is to fit the smokebox to the boiler barrel. Drill a $\frac{1}{4}$-in. hole on the bottom centre-line, just ahead of the hole for the blast-pipe (exact location doesn't matter) for the spigot of the snifting valve. If you haven't drilled the hole for the bearing sleeve of the poppet-valve regulator, do this now, checking the location from the actual job. Then, if the sleeve is temporarily taken off, the smokebox will easily go into place, as it is a simple job to wangle the regulator spindle through the sleeve hole. Put a smear of plumber's jointing all around the flange of the smokebox tubeplate, before pressing home the



Pipe connections at front end

smokebox barrel. If this is a good tight fit on the flange, no further fixing will be necessary; it can't shift, anyway, when the boiler is erected. However, if not so good a fit, put four 3/32 in. or 7-B.A. countersunk screws through clearing holes in the barrel, into tapped holes in the tubeplate flange, to prevent



Oil check valve

any movement whilst the erecting job is under way. Be mighty careful to have the smokebox and boiler lined up, so that the vertical centres are parallel; it would be just too bad to see that shapely little chimney lolling over to one side, as if it were too weary to keep erect ! Alas, I get that feeling myself pretty often, nowadays.

Now stand the boiler and smokebox on the chassis, with the throatplate resting on the ledge formed by the rear stay, and butting up against the curved edges of the main frames, as shown in the side view of the grate and ashpan in place. The firebox should be central over the cradle, and just overlap the top ledges of the ashpan at each side, as shown in the end view. That settles the correct height of the boiler at the back-end. To get it O.K. at the front end, is another simple job. It gives me the proverbial "pain in the neck" when folk carry on about so-called "difficult" jobs, as though they were the only people on earth who could do things; bless your hearts and souls, *nothing* is difficult *when you know how.* Well, the boiler, as I said before, is a true cone, and tapers at both top and bottom. As the firebox end is $\frac{1}{2}$ in. bigger in diameter than the smokebox end, it doesn't need Sherlock Holmes to deduce that the top of the boiler should be $\frac{1}{4}$ in. lower at the smokebox, than at the firebox. Stand your scribing-block by the firebox end, and adjust the needle until it touches the top of the barrel. Then shift it to the smokebox end, and adjust the height of the smokebox saddle in the frames, until the top of the smokebox is $\frac{1}{4}$ in. below the scriber needle. What *could* be simpler ?

Scratch a line along the side of the saddle, level with the top of frame, so that if the height is accidentally altered, it can be restored correctly; then lift off the boiler. Now on the original frame drawing, I showed four holes, two groups of two each, widely spaced, which I intended for the saddle screws. Second thoughts, it is said, are always best, and I've thought of a trick worth two of the above. When putting the saddle in place, I said, take the two top screws out of each cylinder bolting flange. Using the the holes for a guide, drill corresponding holes clean through the angles at each end of the saddle, and put longer bolts in, which will not only help to hold the cylinder flanges, as did the original bolts, but will hold the saddle at the correct height as well. However, don't tighten the nuts "for keeps" yet, as the saddle will have to be temporarily removed to fit the oil pipes.

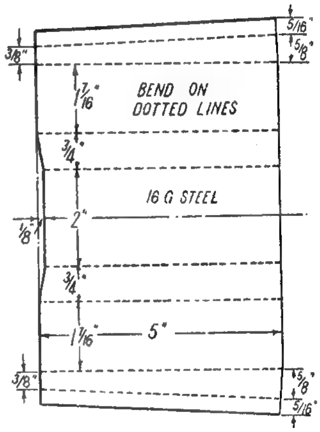
How to Fix the Grate and Ashpan

First replace the boiler, which should now drop easily into correct position right away. If by any chance, the ledges at each side of the ashpan are not in close contact with the bottom of the firebox, adjust position of ashpan until they are. The exact height of the ashpan in the cradle, doesn't matter a Continental, as long as the ledges are up against the bottom of the firebox. Now drill four No. 30 holes clean through sides of cradle and ashpan, as indicated by the slotted screwheads on the drawing. (Our enginemen readers will call these banner signals; and our motoring readers, derestriction signs !) Again, the exact position is of no moment. Countersink the holes on the outside, and put $\frac{1}{8}$-in. or 5-B.A. countersunk screws in, nutting them on the inside, as shown in the back view. That settles the ashpan's hash !

Now lift the boiler again, and stand the grate, on its own legs, in position, as shown in side and end views. The middle part will drop down into the well, naturally, but the end sections should be central with, and parallel to the sides of the ashpan, as near as possible, so that the firebox just clears all around. Temporarily clamp the two back feet to the ashpan, by aid of a couple of toolmaker's cramps (I made a couple of long-nosed cramps which are O.K. for jobs like this) then put the boiler on again, and see if the grate is central with the firebox. You can see partly through the firehole, and partly underneath. If so, remove the boiler again, and attach the feet of the brackets supporting the grate, to the ashpan, by either of the methods shown, viz.: nutted screws through clearing holes in both feet and ashpan, or screws put in from underneath, through clearing holes in the ashpan, into tapped holes in the feet. If the latter method is used, spring washers (commercial article) will be needed under the screwheads, as the vibration, when the engine runs fast, might loosen them, and cause them to drop out. If the pony truck is temporarily removed whilst the grate is being fixed, the job will be quite easy. The retaining gadget for the centre part will be described later.

Oil pipes

As the oil pipes pass through the smokebox saddle, they can be made and fixed right away. The oil from the lubricator is delivered into an auxiliary clackbox, whence two pipes take it to union connections on the main steam pipes outside the smokebox; see view of pipe connections. As the clack is made in an exactly similar manner to the one under the lubricator, there is no need to repeat the ritual; the



Ashpan "in the flat"

sectional illustration gives all the necessary dimensions. Before seating the ball, drill a No. 32 hole clean through the body, just above the ball seating; and at each side, fit a piece of $\frac{1}{8}$ in. copper pipe, approximately $2\frac{3}{4}$ in. long, silver-soldering them in. The outer ends of the pipes are furnished with 7/32 in. × 40 union nuts and cones. After fitting the clack ball, spring, and cap, bend the pipes to the shape shown in the drawing, and lay the assembly between frames, bending

the pipes so that the clackbox comes in front of the exhaust pipe. The smokebox saddle can then be put in place, and bolted up through the upper holes in the cylinder bolting flanges, as previously mentioned. The bottom of the clackbox is connected to the union under the lubricator, by a piece of ⅛-in. copper pipe, with 7/32 in. × 40 union nuts and cones on each end; a simple job needing no explanation. The exact length of pipe needed, can be obtained by measuring between the unions with a bit of soft wire.

Replace the boiler once more, and mark off on the smokebox barrel, through the holes in the saddle flange, the position of the screws holding the smokebox to the saddle. This can be done by aid of a bent-ended scriber; but a favourite trick of my own, when doing a job of this sort, is to fix the broken-off end of a suitably-sized drill in the end of a short length of close-coiled spring, which acts as a flexible shaft, and allows the drill-point to be poked through a hole which couldn't be reached by an ordinary straight drill. Thus countersinks can be made in seemingly "impossible" places ! Anyway, if circles are scribed through the holes, remove boiler, centrepop the circles, drill No 48, and tap 3/32 in. or 7 B.A. The boiler can then be replaced "for keeps," but don't put the screws in until the steam pipe connections are made, in case you need to lift the smokebox when inserting the union connections.

Outside Steam Pipes

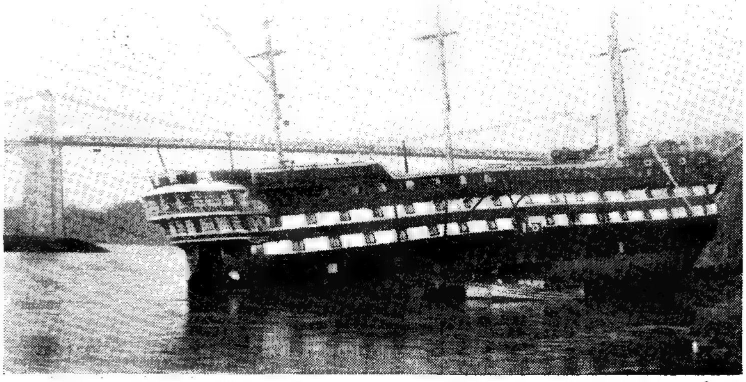
The flanges by which the steam pipes are attached to the cylinders, are cut from ⅛-in sheet brass, and need no description; dimensions are shown in the illustration. I dealt with the job of bending bits of copper pipe, in the notes on *Invicta*, so those directions can be referred to—if necessary !—when bending the bits of ¼-in. copper pipe shown on the drawing. A section of the union fitting which goes through the hole in the smokebox, was given in the notes in December 11th issue, page 767. To make it, chuck a bit of ½-in. hexagon brass rod in three-jaw; face the end, centre deeply, and drill down about ⅞ in. depth with 7/32-in. drill. Turn down a full ½ in. of the outside, to ⅜ in. diameter, and screw ⅜ in. × 26. Part off at $\frac{3}{16}$ in. from the shoulder. Reverse in chuck, chamfer the hexagon, and open out the hole with letter C or ¼-in. drill, for about ⅛ in. depth, to take the steam pipe. Make a lock-nut for each, from the ½-in. hexagon rod, about $\frac{3}{16}$ in. thick.

Now, if you put the fittings temporarily in the holes in smokebox, the latter being in place on the saddle, you can see exactly how long the pipe must be, to fit in the counterbore and cylinder flange. Cut the bits of pipe to length, and put on the flange and union; then, at about ½ in. from the shoulder of the union fitting, drill a 5/32-in. hole in each steam pipe. In these holes, fit a 7/32 in. × 40 union screw, same as the one in the lubricator check-valve, and silver-solder the lot at one heat. Pickle, wash, and clean up, then assemble as shown, putting a 1/64-in. Hallite or similar jointing washer between flange and cylinder, and securing by two 6-B.A. screws, any head you fancy. The union goes through the hole in the smokebox; put a little fillet of plumber's jointing around, where it comes through, and screw the lock-nut down tightly on it. Then connect up the union, as shown in the illustration mentioned above, also the oil pipe unions.

The snifting valve was shown in section in January 1st issue; but in case anybody prefers an entirely detachable one, with a union connection, an alternative type is shown here, which needs no description. Put a bit of plumber's jointing around the spigot before pushing it into the hole in the smokebox bottom; it needs no further fixing. The screws can then be put through the flanges of the smokebox saddle; either round or hexagon heads, as you desire. The back end of the boiler is held down by two expansion clips, as shown both in the back end view and the detail sketch. These clips can be bent up from bits of 16-gauge brass or steel, each being secured by two ⅛-in. or 5-B.A. set-screws running through clearing holes (No. 30) in the clip, into tapped holes in the foundation ring, as shown in section. Warning—keep them well clear of the water space !

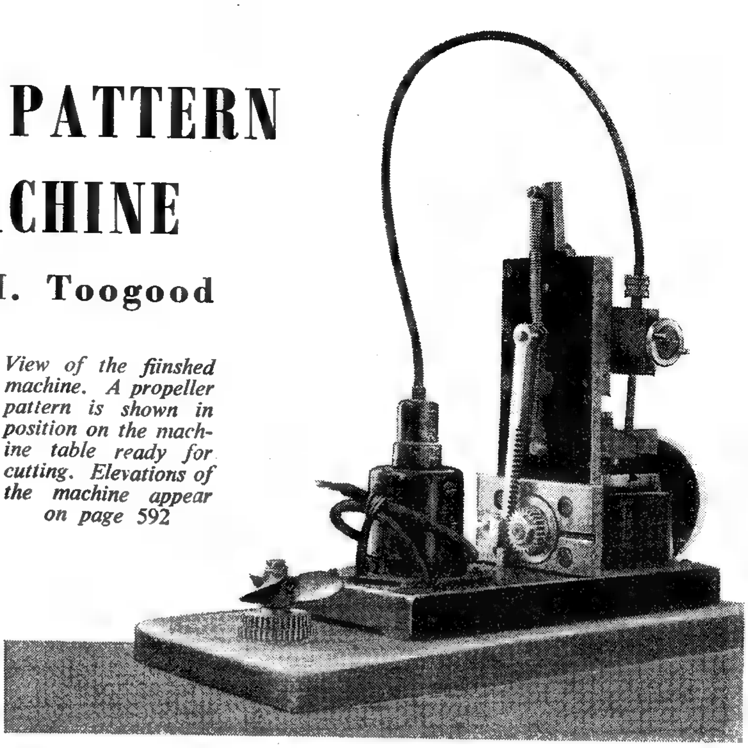
THE LOSS OF THE "CONWAY"

There was a general feeling of regret when it was learnt that the well-known training ship *Conway* had run aground while on tow between her station in the Menai Straits and Birkenhead. She was 114 years old, and although she might have lasted for many years under normal conditions, she was in no state to survive a shock of that nature, and now she has been declared a total loss. The *Conway* had trained officers for both the Royal and Merchant Navies for many generations, and her loss will be felt throughout the world. She was launched in 1839 as H.M.S. *Nile*, a second-rate 92-gun line-of-battle ship, and was fitted with an engine and screw propeller in 1854. After an active career in the Royal Navy she replaced an earlier *Conway* in the Mersey in 1876, and in taking up her new duties her name was changed to *Conway*, thus becoming the third ship to bear the name since the foundation of the Trust. Her work was similar to that of the *Worcester* in the Thames, and it has always been considered a great honour to have been trained in one or other of these ships. We understand that arrangements are being made to transfer the *Conway* School to a large mansion on the shores of the Menai Straits.



PROPELLER PATTERN CUTTING MACHINE

By C. H. Toogood



View of the fiinshed machine. A propeller pattern is shown in position on the machine table ready for cutting. Elevations of the machine appear on page 592

AT the works where I am employed, whenever I have an idea for improving the manner in which an article is manufactured, I make a model in my home workshop, and experiment with it before putting the idea before my employers. About eighteen months ago, my foreman asked me if I had any ideas for a machine which would cut a true-pitch propeller pattern.

Most propeller patterns are made by hand; the pattern is built up of layers of wood, each layer overlapping the lower one The surplus wood is removed with a gouge and mallet. It is then tested with a pitchometer, and more wood removed, till the pitch is approximately true. Then it is turned over, the back finished off, and the blade cut to shape.

The machine I made will cut the pattern from a solid block and generate the pitch accurately. It can be cut with a positive, neutral or negative rake. I started making a model, and I built it up, instead of using castings, as I knew there were bound to be alterations, before it worked properly.

I first experimented with cams, but found these were very difficult to design, to get the desired result. Also I came to the conclusion, that a cam for every pitch would be very expensive (on a full-size machine). Then I thought of the rack and pinion idea and this worked satisfactorily.

The only reason for the use of springs, was to take up backlash, in the bevel gears, as these were second-hand, and a poor fit. A machine fitted with a pair of properly cut and adjusted bevels would need no springs.

Rack and Pinion

These were cut with a 20 diametrical pitch cutter. This was the only one available (I bought it to cut some special change gears). On a full size machine it would be better to use circular pitch cutters to obtain standard pitches.

Using a 20-diametrical pitch cutter, a 20-tooth gear gives $20 \times 0.157 = 3.140$ pitch on the propeller pattern. A 30-tooth gear gives a pitch of $30 \times 0.157 = 4.710$.

Using a ⅛-in. circular pitch cutter, a 20-tooth gear gives a pitch of $20 \times 0.125 = 2\frac{1}{2}$ in. A 30-tooth gear gives a pitch of $30 \times 0.125 = 3\frac{3}{4}$ in.

I made up my mind to copy a vertical boring machine, for the main parts of the machine.

After making rough sketches, I hunted around for material, including the following items; round steel for base and table, etc., flat steel for backplate, packing piece, rack-guide plate, and horizontal slide backplate, round bronze for bearings, etc. All the above were obtained from a local engineering works. The cast-iron stand came from a scrap dealer, and the electric motor came from a small tool grinder.

Flexible Drive

This was a cycle speedometer drive; bevel gears were obtained from my scrap box, and years ago, drove a magneto on a petrol engine. The crown wheel and pinion also came from the scrap box, and originally formed part of a hand drill. The cutter was made from a rotary file, springs were obtained from a garage, while the bolts, nuts, set-screws, grub-screws, B.S.W., B.S.F. and B.A., were selected from a box of odd screws etc., and the ball bearings came from a burnt-out carpet sweeper.

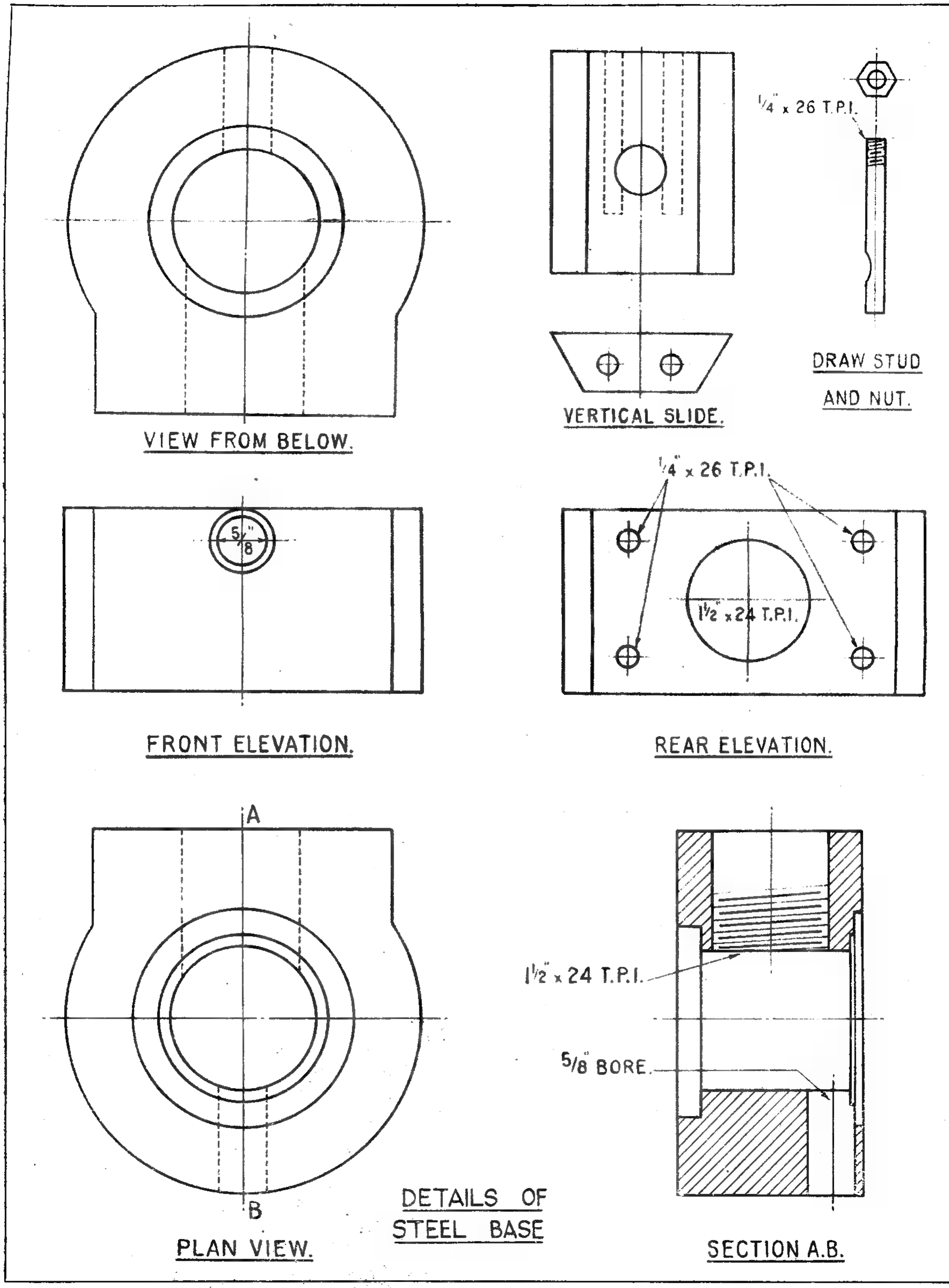
The piece of round steel for the base was first taken in hand. I found that when held in my three-jaw chuck, it chattered badly, so I drilled and tapped two ⅜-in. holes, in each side of it. I then fastened it to faceplate, with set-screws, machined it all over, and drilled a ⅝-in. hole in centre. It was then set up on an angle-plate on the face-plate, with a bolt through the ⅝-in. hole, and machined on the circular part till a flat $3\frac{3}{4}$ in. wide was obtained, after which a recess was turned, $1\frac{5}{8}$ in. diameter, $\frac{3}{16}$ in. deep. A piece of flat steel $3\frac{3}{4}$ in. $\times\ 2\frac{1}{4}$ in. $\times$ 1 in. was machined all over, and a spigot turned one side, to fit in the recess.

This was fitted to the base with two countersunk screws, then set up again on angle-plate, faced, bored and threaded for main bearing ($1\frac{1}{2}$ in. $\times$ 24 t.p.i.). It was next put on faceplate again, and bottom side faced, and bored for bottom bearing-plate. It was then reversed and top faced, bored and recessed for bronze bush for the spigot of table.

Machine Table

The piece of round steel for table was chucked, faced and recessed, and turned to $3\frac{7}{8}$ in. diameter. It was then reversed, turned down, and threaded 24 t.p.i. for the crown wheel and bevel gear. A $\frac{5}{16}$-in. B.S.F. hole was drilled and threaded right through.

The table was reversed in the



DETAILS OF STEEL BASE

PROP

CUT

DET

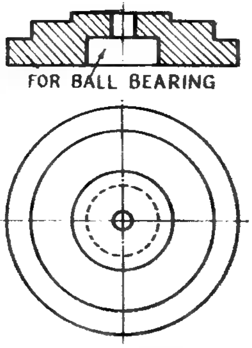
(Back pl

with

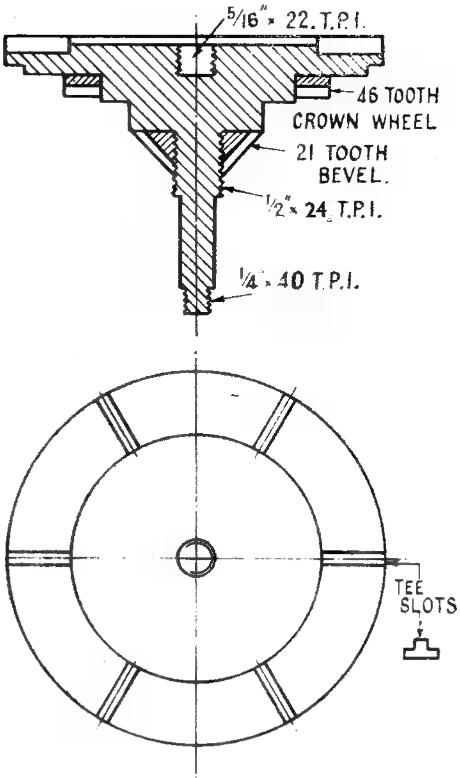
PELLER PATTERN
TTING MACHINE

AILS OF COMPONENTS

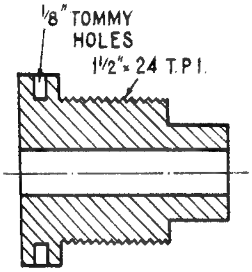
(...e, Rack and Cross-slide will appear
...e continuation of this article)



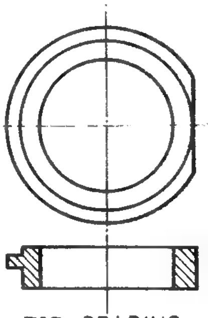
LOWER BEARING FOR TABLE.



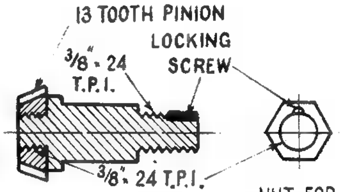
MACHINE TABLE.



BRONZE BEARING FOR BEVEL GEAR SHAFT.

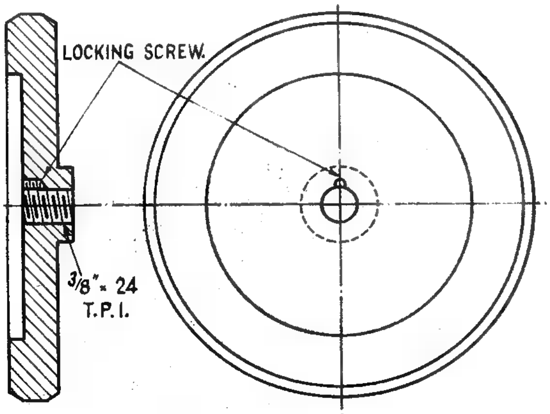


TOP BEARING FOR TABLE - BRONZE.

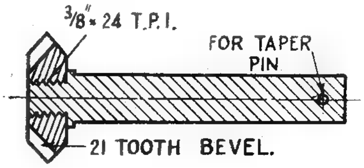


STEEL PINION AND SPINDLE FOR HANDWHEEL

NUT FOR HANDWHEEL SPINDLE



STEEL HANDWHEEL. KNURLED ON EDGE.

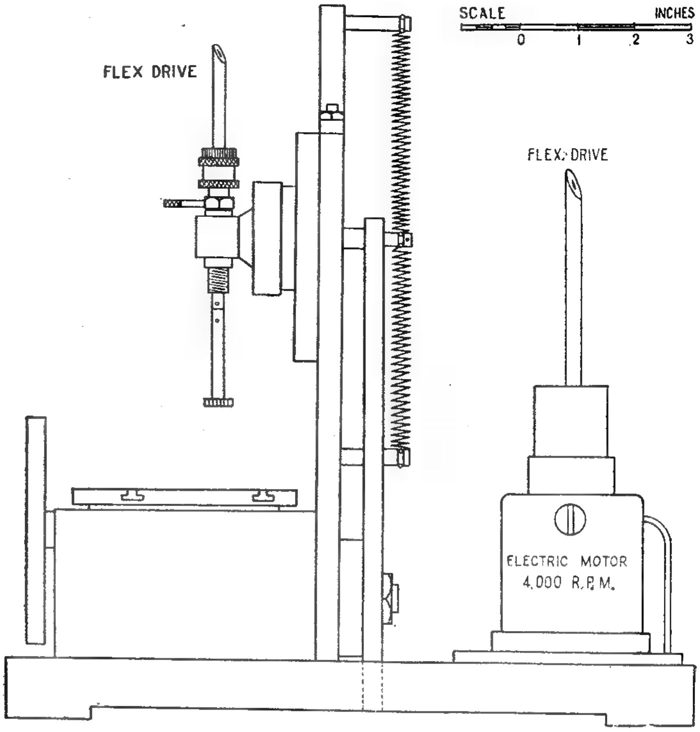


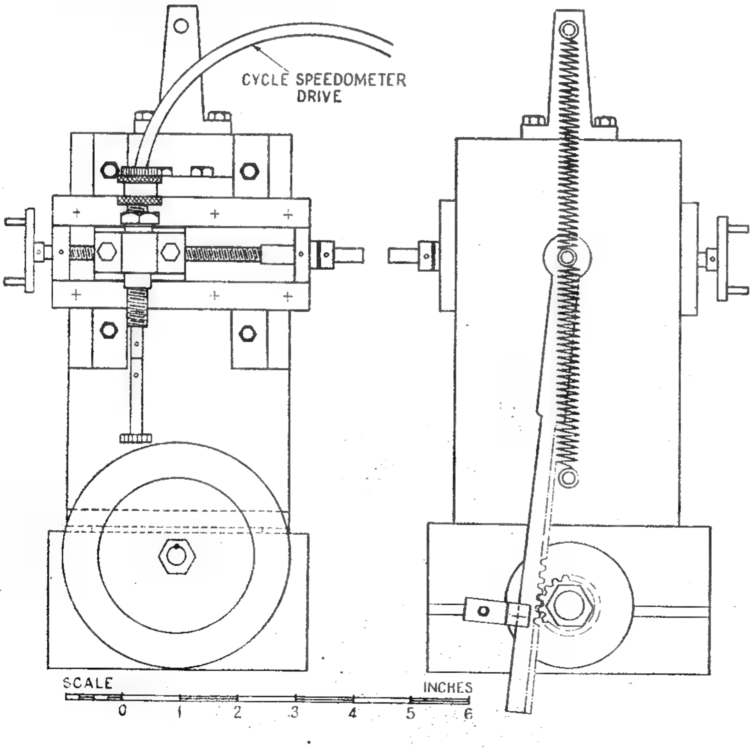
BEVEL GEAR AND SPINDLE - STEEL.

chuck, and with the milling spindle mounted on the slide-rest, and a change wheel mounted on end of mandrel as a division plate, the tee-slots were cut. The bottom bearing-plate was turned to fit the recess in the bottom of base, and bored for the ball bearing. One end of the spindle was then turned, and screwed to fit in the lower side of the table, and the other end turned to fit the ball bearing, also a retaining nut. The crown wheel and bevel gear were bored and threaded to screw on the lower side of the table, and secured with grub-screws, half in gear, half in table.

A bronze bush was turned and fitted to the top of base to form a bearing for the table, which was then placed in position, also bearing plate, ball bearing and nut. The base was stood on the surface-plate, and a scribing block set to the centre height of the hole for the main bearing. The arm of the scribing block was pushed through the bearing hole, and a line scribed on the spindle under the table. After removing the latter, the bevel gear was meshed with the bevel under the table, and its centre compared with the scribed line. The difference between these two was removed from the face of top bearing.

The bush for the main spindle was machined to fit the threaded hole in the base, and the spindle was turned, and screwed in bevel gear. This was inserted in the bush, and screwed in the base. Adjustment was made by facing back the bush till the gears meshed properly, with the shoulder screwed hard up to the base.





The assembled base was again stood on the surface-plate, and with the aid of the scribing block, the position for the spindle of the pinion which meshes with the crown wheel was marked. Once again the base was put upon the angle-plate, and the hole bored and faced for the pinion spindle bush. The spindle was turned, and the pinion threaded and screwed on the spindle, and secured to the spindle with grub-screw, half in pinion, half in spindle. To ensure the proper location of the bush, it was tapped into the hole in the base, till the gears meshed, after which it was secured by a grub-screw. The handwheel was turned from a piece of 4 in. steel, knurled on the outside edge to obtain a good grip. Its boss was threaded $\frac{3}{8}$ in. $\times$ 24 t.p.i. to screw on spindle, adjusted on the latter to take up end play, and then locked with a nut, which was secured with a grub-screw, half in nut, half in spindle.

(To be concluded)

READERS' LETTERS

Letters of general interest on all subjects relating to model engineering are welcomed. A nom-de-plume may be used if desired, but the name and address of the sender must accompany the letter. The Managing Editor does not accept responsibility for the views expressed by correspondents.

THE SMALL ELECTRIC MUFFLE

DEAR SIR,—I have recently constructed the above as described by "Duplex" in THE MODEL ENGINEER of December 11th last. I did not deviate from the original design in any way, with the exception that the only bowl-fire element I could obtain was of 500 W rating.

On completion of the job I switched on, and after what seemed approximately three or four minutes a nice yellow glow showed through the window (about the same colour that a fire element normally glows). I looked around for a piece of ½-in. steel to try in the muffle, when I noticed that it was losing heat, and on checking for continuity found that there was an open circuit.

I removed the slag wool lagging and discovered that the element had failed about ½ in. from the rear binding-screw.

I thought possibly the wire had been damaged where it was bent at right-angles, so having checked the resistance of the element and found this to be approximately 110 ohms, which seemed reasonable for 500 W loading, as the voltage in my workshop is usually less than 230 V, I remade the connection (the element showed no signs of oxydisation) and replaced the lagging for a further test.

I switched on and checked the time taken to reach a nice yellow glow, which was three minutes, when the element again failed, again about a ½ in. from the rear binding-screw.

I have a copy of THE MODEL ENGINEER handbook on Hardening and Tempering, and notice that it is stated that the 200 W "Fulmar" furnace manufactured by Mr. Avery will maintain a temperature of 1,560 deg. F., also that the elements for these furnaces are wound with nickel chrome wire for temperatures up to 1,832 deg. F. I can find no information re the melting point of nickel chrome, but I should not have thought I was exceeding this, and it would appear that the element was not overrun electricity.

Perhaps "Duplex" will be good enough to offer a few comments.

Yours faithfully,

Leatherhead. R. H. COLGATE.

CORLISS VALVE GEAR

DEAR SIR,—I note in the April 2nd issue a query from "J.H.G." of Salisbury on the above subject and your reply.

If "J.H.G." can get hold of copies of THE MODEL ENGINEER for March 3rd and 20th, May 15th, July 31st and August 7th of 1913, he will find full details, not only of the valves, but of the whole of the operating gear too, being part of a series on "Automatic Expansion Gear," by the late Hy. Muncaster.

Both drawings and descriptions are fully up to the always high standard of this fine old engineer. The gear you illustrate is a comparatively crude form; Muncaster's shows a much later development.

This type of gear probably found its greatest use in mill engines, though it has been used in marine work and for locomotives (the latter principally in France). When used for these purposes, the trip and governor gear was omitted and the valves were operated by a normal reversing valve-gear, usually Gooch's link motion. The gear is *not* suitable for high speeds.

In THE MODEL ENGINEER for September 15th, 1901, there is a well illustrated description of a model of a tandem compound mill engine made by Mr. Adam Gilbert, one of the finest stationary engine models ever described. This beautiful model now reposes in the Science Museum at South Kensington, and it is a truly magnificent piece of work. In spite of the fact that it now reposes in a glass case, it is a perfect *working* model.

Yours faithfully,

Rustington. K. N. HARRIS.

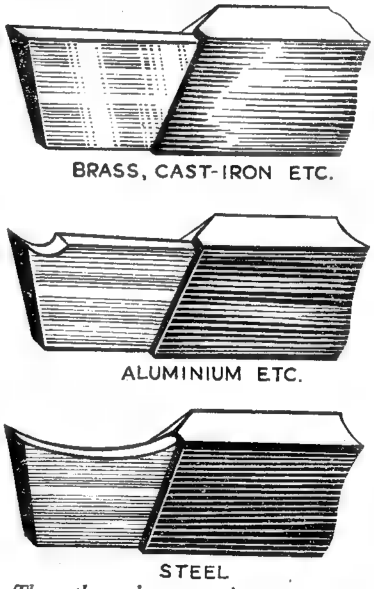
PARTING TOOLS

DEAR SIR,—We are most interested in the letter from your correspondent H. E. Rendell in the issue of THE MODEL ENGINEER dated March 5th, 1953. It is true that the majority of parting tools, although having front and side clearance, are supplied without positive top rake, as the tool manufacturer is unaware of the specific class of machine on which the tool is to be used, or the material to be worked, and, therefore, leaves the matter of top rake to the tool user.

In Mr. Rendell's toolpost design, the tool is presented to the work at a rather fierce angle, and while this would probably be satisfactory for use with ferrous materials on heavy lathes, the smaller machines require rather less top rake.

Another weakness with this type of holder is that if top rake is not required, the underside cutting face must be ground away at a negative angle.

The Myford rear toolpost, which incorporates means of height adjustment, and allows some latitude in top rake adjustment, is in our opinion more satisfactory. This is designed to enable standard-shaped



These three shapes are in common use

tools, including the Myford quick-setting and standard tool bits, to be used effectively, thereby effecting economy in the number of tools required. Rear toolpost application is also an advantage when the form tooled profiles are machined. The angular arrangement of Mr. Rendell's proposed toolpost would complicate matters when form tools are used.

The standard type of parting tool, as purchased, would be entirely satisfactory when set up horizontally

(*Continued on page* 596)

TWIN SISTERS

by J. I. AUSTEN-WALTON

I SEEM to have got out of step once more, due to the fact that I wrote the copy before completing the drawing. When the latter was finally completed, I found that the ashpan and grate had to be left out, as there was no space in which to include them. This also goes for the firehole door, but the next drawing will give them preference and the amount of detail they deserve, so we shall have to wait until the next instalment before these can be cleared.

Meanwhile, there are still a few points to be cleared up, and the superheaters are the first that come to my mind. The drawing gives full details to the extent of two separate forms of wet headers, and some readers may wonder why.

The smokebox on this locomotive is very short, and after having worked out the first system, I felt I would try to make the header come closer to the tube plate; it also appeared to be an easier job to make, and for that reason alone, I knew it would be popular. In both cases, the header tube provides a six-inch spare length of tube, running from one end, which will be bent later when the smokebox is made, to an easy connection to the snifting valve (or anti-vacuum valve), situated at the bottom of the smokebox. For the moment, I shall not bother you with this, as it rightly belongs to the smokebox, and, once fitted, there it will remain for keeps, even if the boiler has to be removed for some reason.

The superheater spearheads were shown quite clearly, but the material was not specified. These and the tubes should, of course, be copper. The section of the spearhead may appear to be impossible to machine, especially if the holes for the tubes are drilled parallel to each other. You could, quite obviously let the two holes converge slightly, disregarding the risk of the drill doing horrible things when breaking through, and it is with this in mind that I recall the drawing for further treatment.

By all means, drill the two holes either actually breaking into each other by means of the removable plug as described before, or leave them with the finest possible bar between them. The desired " break-through " may then be achieved by using a dentist's discarded " burr " as the excavating tool.

Some people say that they have no luck at all with this tiny form of " end-mill "—which indeed it is. The secret here is speed—even 20,000 r.p.m. if you can get it. The steel used to make these burrs is wonderfully hard and tough, and one really has to work hard to destroy or break one; I wish all end-mills were made to the same specification. Copper is not very pleasant metal to work on at the best of times, and some sort of lubricant should be used during excavations. I find that human saliva is as good as anything.

Making friends with a dentist usually results in assuring a life's supply of dental burrs, which, in any case, are thrown away after quite a brief period of work; I imagine a dentist who persisted in using blunt burrs would very soon become unpopular with his patients, and so, wisely he pensions the burrs off in good time.

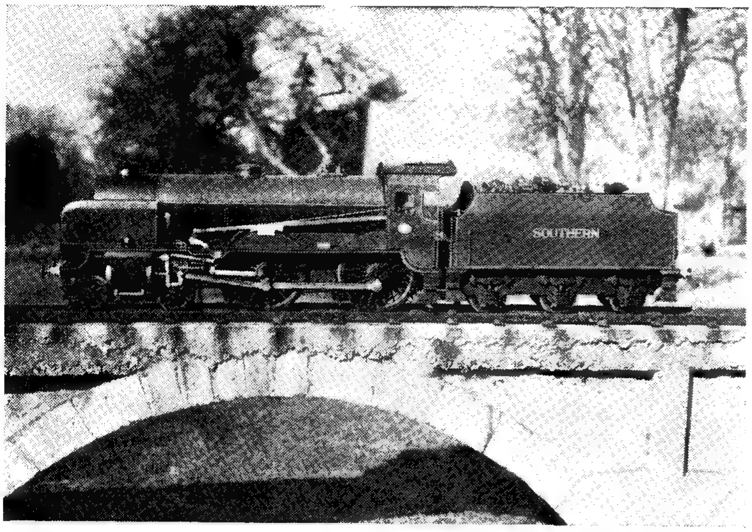
Having a high-speed spindle of some kind in the workshop is invaluable for a wide variety of jobs, and is not difficult to fix up. At speeds of 10,000 r.p.m. and upwards, this calls for a specially free-running type of bearing, but not necessarily ball-bearings. I favour the glass-hard steel cones running in hard steel cone bearings to match. The operative word here is " match," and upon which the successful running of the spindle will depend. This does not mean that such bearings are hard to make; it does necessitate getting the turning angle for the cones set round on the swivelling top-slide, and maintaining this same setting undisturbed whilst boring the mating bearing, a condition we must also observe carefully when making taper reamer D-bits for plug cocks. After hardening, both cones and bearings must present a mirror-like surface, a condition best obtained by lapping the two parts together. Most of the abrasive-manufacturing firms who put up lapping compounds in various grits and grades, also make a special emulsion, commonly known as " mating compound." I have used this material with great success on a number of different jobs, and was quite surprised to note that, once the hard and harsh feel of metallic interference had been lapped away, there was no further tendency for the compound to go on with its cutting action. There is no " magic " about this, and apparently the actual cutting medium suspended in the supporting fluid, requires considerable pressure to promote the cutting action. Where there is a harsh form of interference, such as we find when one high spot comes into direct contact with another high spot in two mating surfaces, the offending bumps are soon reduced. A good angle for turning the cones is 20 deg. (included angle).

All this may sound meagre information for the making of a high-speed spindle, but it covers the essentials for a spindle that may be run at very high speeds without damage or overheating, and provided normal lubrication is catered for. The average locomotive engineer will soon set about making something, once the seed of the idea is sown. Getting the required speed is also comparatively simple. It must be borne in mind that minute drills, cutters and burrs are never called upon to remove large quantities of metal, and a motor of moderate horse-power, say $\frac{1}{4}$, driving through the lightest form of belt transmission, will easily achieve the high speed required. This may be done by using a number of pulleys and countershafts where ball-bearings do come into their own. The belting, especially in the later and high speed stages, may be nothing more than round leather boot laces, cut and spliced together to give a clean " bump-proof " join.

Flexible drives are also found in a number of workshops, but are, in my experience, never very popular. At very high speeds they absorb a lot of power, the bearings get very hot, and very often they seize up altogether.

A fixed vertical or horizontal high-speed spindle leaves the operator with two hands for working—a condition that gives him much more control over the job. Clearing out difficult corners in castings is one of the jobs that are run into frequently, and in this particular case, I use dental burrs a great deal; they get completely ruined by sand in the

Continued from page 545, *April* 30, 1953.



Mr. C. Hammond's 5-in. gauge locomotive

casting, but that is of small moment when the supply of fresh ones is through such free and copious channels.

At a recent trade exhibition, I watched a demonstration of a tungsten carbide cutter of about $\frac{3}{16}$ in. diameter, running at a fantastically high speed, calmy eating its way through the hardened outer race of a ball-bearing. After the demonstration, one expected to find little more than a charred ember on the end of the spindle shank, but there was the cutter, indistinguishable from new and ready for a fresh assault.

Front Blower Pad

Straying away again, I'm afraid, but there is further comment to be made concerning the blower attachment in the smokebox. The drawing shows a simple pad, brazed to the front tube plate, and left at that. There are different ways of dealing with this connection, first of all by the simple mating pad to which the blower extension pipe is silver-soldered, and fixed to the parent pad by three or more small studs or set-bolts.

The actual pipe connection might be straight out from its centre, or via the edge (like the blower connection shown for the backhead connection), but there is no particular advantage to be gained by doing this, as the extension pipe runs straight forward first, before diving down close to the right-hand side of the smokebox, and then turning in to meet the blower ring connection. Secondly, a simple union might be brazed to the parent pad, being, in fact, part of it when made. When I made my boiler, I used a piece of tube to run through the barrel, projecting through the parent pad by about half-an-inch. This tube was of the thick-wall variety, commonly known as "blower tubing." This permits of the direct threading of the tube itself, and I made use of this feature to make it the male half of the required union. A word of warning here; one often comes across a form of thick-wall tube offered as blower tube, from surplus disposal firms. This is really capillary, or thermometer tubing, and as a rule, the bore is much too small. Never forget that a purely *local* restriction in a steam pipe or fitting, will not affect the flow of steam past it seriously, but in a long and sustained case of restriction, such as is found in the case of a blower pipe running the length of a boiler barrel, the flow of steam may be reduced too seriously.

And now, apart from the description of the grate, ashpan, and firehole door, we may close the door on the boiler itself, and go on to consider the remaining parts.

Details and Details

More than ever, lately, the question of detail in its many and varied forms, has come to me through the mail, personal contacts, and society gatherings in many places. It would appear that the broad definition of detail has a number of different interpretations, according to the type and size of model being built. To one man, details mean actual working parts deemed to be necessary for the full working functions of the whole assembly; thus, in the case of a locomotive, described in a catalogue as super-detailed, I have found myself not a little

Proportions are so important

surprised when surveying an engine on which every single working component that ever adorned a full size locomotive was staring at me with an almost insolent defiance. To be quite honest, I was not impressed and more nearly disgusted. To start with, some of the steam fittings I recognised as having come off a very, very ancient type of acetylene generator. The machining and general finish of these parts was excellent, unfortunately something we do not find on modern commercial parts. The over-large knurled "hand-wheels" were dished out and lacquered ruby, making them reminiscent of the better type of microscopes of a decade or so ago. The only full marks that I could award the somewhat proud owner, were for sheer ingenuity. Just how he managed to screw so much oversize control into such a crowded space, got me beaten entirely, and I came away not completely convinced that they *were not all screwed home*. Functionally, the model complied with the loose definition of "super-detailed," but it certainly left me wondering if any other enthusiasts had fallen for this particular definition, so completely and thoroughly.

At the extreme opposite to this case, once when I was in the North, I was invited to inspect another locomotive about which a good report had circulated. From six feet away, when my eyes first set on it, the result was most pleasing, and closer inspection that followed, added to the satisfaction gained from the first introduction and the more casual look-over. I pointed to the beautifully-proportioned and finished cylinder drain cocks: "Working, of course?" I queried. "Oh, no, they are much too small to operate," came the disappointing reply. I hope my obviously shocked look was not noticed. I was tempted to contradict him outright, but kept my feelings to myself. The amount of work that had gone into the making of those dummy pipes and fittings, might just as well have been furthered to the extent of putting 3/32-in. pipe in place of the 3/32-in. rod. Going still more closely into matters, additional "dummifications" came to light in the cab, all with the same meticulous care as to proportions and finish, and all with the necessary physical space for the real article. I hope that the owner of that otherwise excellent locomotive, if he happens to read these words, will not think unkindly about me, but will, with his next attempt, think twice about the fittings dept., because he has, quite obviously, the necessary skill and patience to complete the job as it *should* be completed.

The truly important thing about detail, when it appears *en masse* on a locomotive, is its ability to make or mar the full-size "atmosphere" of the prototype. I am showing you this week, two shots of a 5-in. gauge locomotive, built by that well-known enthusiast, Mr. Cyril Hammond. He has chosen a type that needs especial care in exact reproduction, and although some of the Southern experts will get out their magnifying glasses, later to declare that the chimney and dome are wrong, or that there is not enough "tumble-in" to the cab sides, I feel that he has succeeded in capturing the essential and, sometimes very elusive character of that most famous and graceful locomotive of the Southern line. She also looks as though she will be just the job for the arduous duties of the track, for which I am sure she has been built.

Mr. Hammond should be congratulated by all those locomotive builders who know how very hard it is to combine the qualities of good and correct looks with those of working efficiency, and the toughness to maintain it.

Very soon now, we shall be at the stage where the rather pernickety work of making small but sensible steam fittings, begins; I shall attempt to show you that, to design a fitting, there is more to it than searching in the scrap box for a bit of hexagon brass rod, and later, drilling and tapping a number of holes in it. We shall see that, strange as it may seem to those who have not previously considered scale fittings, the time to make such parts is seldom greater than that required to produce the more usual or functional type of fitting.

Not only that, the unnecessarily large or clumsy fittings introduce new and vexing problems of their own, the most vexatious of these being the jig-saw puzzle of "what-to-screw-in-first" and "will-this-miss-that-when-in-place." For such reasons alone, the problem goes far beyond that of designing a single fitting; it has to embrace the entire range of fittings to be used, and their proximity to each other. We all know by now the restrictions placed upon us for scale considerations, such as with water gauges and certain other items, but by careful planning ahead we can make sure that such *necessarily* enlarged components are not thrown into unfortunate relief or emphasis, due to the close proximity of some other part that needs no such treatment.

And there I must leave you; my most urgent job is to complete the remaining bits that screw on to the boiler, and issue the drawing at an early date.

(To be continued)

READERS' LETTERS

(Continued from page 593)

for material such as brass and cast-iron. For materials such as aluminium or copper, a lipped tool is an advantage, and for steel, the top rake which is produced on the periphery of a 6 in. diameter grinding wheel will give satisfactory tool support. The tool should approach the work-piece in a smooth and non-violent manner, and continuity of feed is very desirable for satisfactory work.

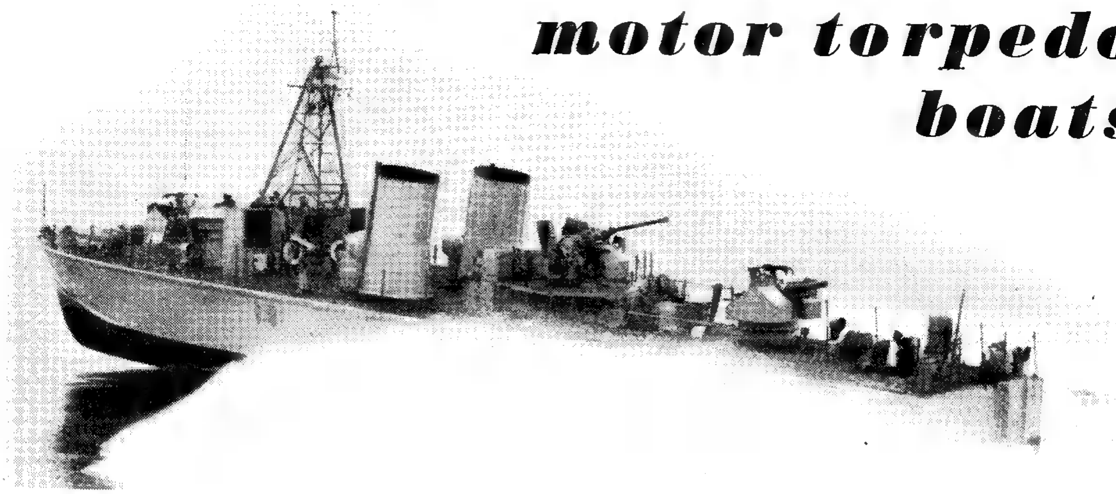
Front clearance is as important as top rake. Too much clearance weakens the tool, and can cause chatter when used in conjunction with positive top rake. Too little front clearance results in the tool rubbing, and imposes unnecessary wear and tear on the feedscrew and nut; also, there is a risk that the tool will dig in when it does decide to take a bite. This applies when using parting tools either in the front or rear, but greater efficiency is obtained with rear tool application.

Further Mr. Rendell's comments on the Super 7 headstock spindle, the large taper front bearing presents a solid support against the cutting pressure of the tool, and is particularly valuable in parting-off. This type of bearing is naturally more expensive to produce than the straight journal types, and its advantages are most pronounced in metal turning where high speed and durability under industrial conditions are prevalent.

The countershaft clutch as fitted to the Super 7 lathe (a similar clutch is also available as an extra to the M.L.7) facilitates the control of the lathe, and eliminates the necessity for starting and stopping the motor on every occasion, thereby saving wear and tear of the motor and switch gear.

Yours faithfully,
MYFORD ENGINEERING CO. LTD.

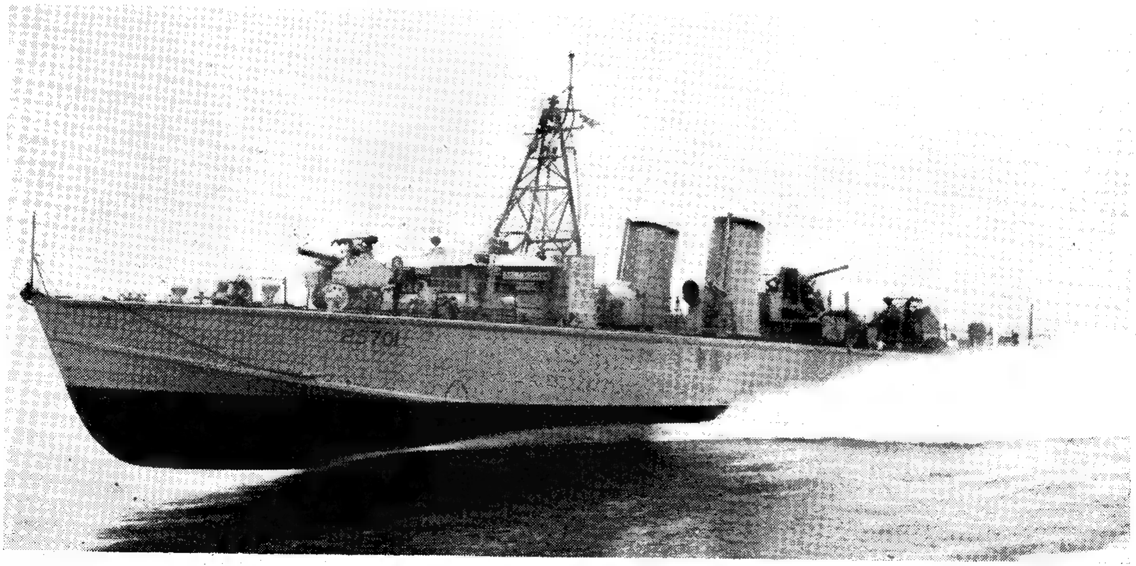
Turbine-diesel motor torpedo boats



THE first two motor torpedo boats of the Royal Navy to be powered by gas turbines in combination with diesel engines will be completed for service shortly. They are Her Majesty's Motor Torpedo Boat *Bold Pioneer*, launched in August, 1951, at the Cowes, Isle of Wight yard of Messrs. J. S. White and Co. Ltd., and Her Majesty's Motor Torpedo Boat *Bold Pathfinder*, launched in September, 1951, at the Portchester yard of Messrs. Vosper Ltd.

Both craft are fitted with gas turbines made by Messrs Metropolitan Vickers Electrical Co. Ltd., of Manchester, the main machinery installation having been undertaken in each case by the shipbuilder. The turbines have been developed from the Gatric engine which operated so successfully in M.T.B. 5559 (*ex*-2009) in 1947. An interesting feature for the model maker is that the two funnels are placed side by side as in the Victorian period, although the funnels themselves are short and oval, as in modern practice. The craft are largely sister vessels and we understand that both will be armed with four 21-in. torpedo tubes and one small gun.

The principal dimensions of the craft and the details of the machinery installations differ slightly because the boat built by Messrs. White is of hard chine, and that built by Messrs. Vosper of round bilge form. The principal dimensions of Messrs. White's boat *Bold Pioneer* are :—Length overall, 121 ft. ; length between perpendiculars, 116 ft. 3 in. ; beam, 25 ft. 6 in., whilst those of Messrs. Vosper's boat *Bold Pathfinder* are :—Length overall, 122 ft. 8 in. ; length between perpendiculars 117 ft. ; beam, 20 ft. 5 in.



The Allchin "M.E." Traction Engine

TO 1½ INCH SCALE — BY W. J. HUGHES

BEFORE broaching the centre for the change-speed wheels, it will be necessary, of course, to harden and temper the broach. But first relieve the teeth by filing the lands with a small-tooth file, at an angle of about 2 deg. Be careful not to take anything off the cutting-edges themselves, though.

Now heat the tool to "cherry-red," and plunge it vertically into aired water to harden it. Polish the spaces between the rows of teeth with emery, and temper at a light straw colour. Probably the best way to do this is with the broach enclosed in a tube over a gas-ring, so as to heat the tool evenly all the way along, but mine was done by heating it fairly gently in the flame of a Bunsen burner, rotating it and moving the flame backwards and forwards to obtain the same result. When light straw colour was attained, the tool was plunged into the aired water again.

There are two or three ways in which it may be forced through the hole in the centre. If the vice jaws will open wide enough, it may be forced through in the vice. Alternatively, if you have access to a screw-press, this may be used. The third alternative is the use of a hammer and a modicum of brute force, and that is how I did it. In passing, that is the reason for pressing the gears on to the centre before broaching, so that they strengthen the comparatively weak cast-iron.

In this method, open the vice jaws sufficiently to clear the broach as it comes through; have copper vice clamps in place to prevent the surface of the gear being damaged. Place the centre in position over the opening, with the grooved boss and slow-speed wheel uppermost, and insert the pilot part of the broach in the bore, with the teeth in line with the grooves.

Interpose a piece of brass bar, 1 in. or 1¼ in. diameter, between the upper end of the broach and the hammer, to protect the former, and start to drive the broach through. A 1 lb. or 1½ lb. hammer is suitable. Make chalk marks against one of the grooves and one of the rows of teeth so that the tool will "go back" in the same position after withdrawing.

Keep doing this in order to clear the swarf from the teeth: it will doubtless be necessary to turn the work over and drive the broach out from the other side, using a short length of ⅜ in. brass bar as a drift until the pilot has penetrated sufficiently far through the bore. In doing this, support the work on the slow-speed wheel and not on the grooved boss, or you may bust a piece off the groove!

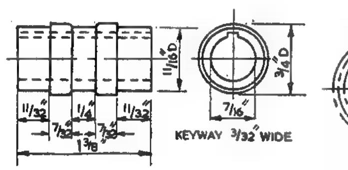
You will recall that I made my broach at too steep an angle, and this meant that it gave too much work for the teeth to do really. Accordingly I found it desirable from time to time to use a small (4-in.) warding-file on edge to ease the "steps" formed in the grooves by the teeth. You should not find this necessary, but if you do, take care not to file the *sides* of the grooves at all.

By the by, I did not use any lubricant when broaching the grooves but I notice that Mr. Lawrence H. Sparey, in his recent article on broaching, advocates this even with cast-iron as giving a better finish. At the same time the finish in my grooves is very satisfactory, so the reader can please himself on this point.

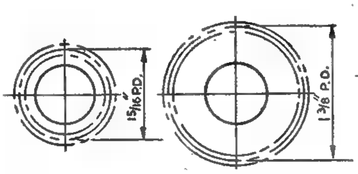
When the broach has gone right through, try the shaft in the bore. You will probably find that it tends to fit better in one position; in my case, the splines would enter in one place, but would not quite in the other three, and in this position it was possible to drive it lightly through the bore. This position was marked by a centre dot on both parts, and it was found that the "high" parts on the sides of the splines had been polished by the contact.

These high places were eased with a fine file, as was the one high spot on the $\frac{7}{16}$ in. diameter, until the gear-centre slid smoothly, *but without shake*, on the shaft. This operation should be done very carefully, as only a thou. or so should need to be removed.

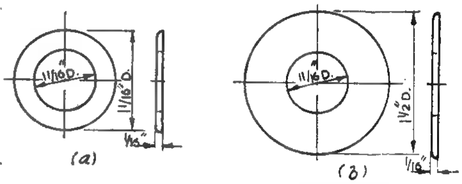
The shaft was then placed between centres, and spun by hand, when it was found that the gears ran perfectly true. This, it may be admitted, was a relief, even though no trouble had been really anticipated. Another hurdle over!



Centre for change-speed pinions



Dimensions of slow and fast speed pinions



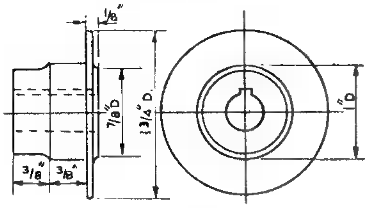
(a) Shrouding for slow speed pinion; (b) Shrouding for fast speed pinion

Centre for Change-speed Pinions

The centre for the change-speed pinions may be turned from ⅞ in. diameter mild-steel bar. Grip a suitable length in the chuck, with about 2 in. projecting. Face and centre the end, and drill to a depth of 1¾ in., using successively larger drills until ⅜ in. diameter is reached. Now bore out the hole to $\frac{7}{16}$ in.

Continued from page 483, *April* 16, 1953.

diameter as before described. In this case, since the hole is blind-ended, however, its inner end should be previously counter-bored with a groove, to allow the tool to clear at the end of each pass.



Centre and shrouding for second motion pinion

Now turn the outside to the diameters and lengths given, with the exception of the seats for the gear wheels. These naturally must be a press fit for the bores of the wheels, and will so have to be fitted as previously described. Regarding the one nearest the chuck jaws, it may be preferred to leave this oversize, and to finish turn it mounted on a mandrel, after parting off. The central groove, which is $\frac{1}{2}$ in. wide, is for the belt of the governor, and so the *exact* diameter is not vital.

Part off to length, and mount on a stub-mandrel, or on a mandrel between centres, to finish the wheel-seat, if not previously done. Then grip the piece in the three-jaw chuck, and slot out the keyway in the same way as those of the other gear centre. This time, however, the tool-bit should be 3/32 in. wide: its depth should be a gnat's whisker more than 3/64 in., so that it will just clear the top of the key which will be sunk in the crankshaft.

Pinions and Shrouds

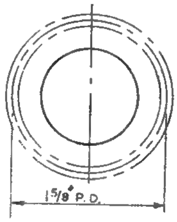
The pinions are both 16-pitch and have a face width of 9/32 in.: that for the slow speed has a pitch diameter of $\frac{15}{16}$ in., giving it 15 teeth, and the fast speed pinion is $1\frac{3}{8}$ in. p.d., giving 22 teeth. They may be pressed home on the seats of the centre, using the vice jaws as a press: a bush or short piece of tube will be necessary to press them right home, as with the fast speed spur-wheel.

The shrouds for the two pinions fit on the outsides, and may be parted off from mild-steel bar of the appropriate size. Face up the end of the bar, centre, and drill and bore the end out, say, $\frac{1}{4}$ in. deep, just to fit over the projecting $\frac{1}{16}$ in. spigot of the pinion centre. Turn the outside to diameter, and part off to a shade more than $\frac{1}{16}$ in. thick.

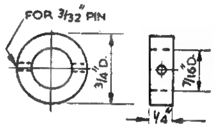
To fix the shrouds to the pinions, coat the faced-up side and the bore, the face of the pinion and the spigot, with solder paint, and sweat them together. Wash well in water to remove any traces of flux, and then the outer faces of the shrouds may be faced to thickness, with the work mounted on a mandrel. Note that the outer corners are rounded slightly.

Second Motion Pinion

The second motion pinion has a pitch diameter of $1\frac{5}{8}$ in. (26 teeth of 16-pitch), and is $\frac{5}{16}$ in. across the face of the teeth. It is pressed on a cast-iron centre which is keyed on the second shaft, outside the horn-plate. This centre incorporates the shrouding for the gear teeth.



Dimensions of second motion pinion



Collar for second shaft

To machine the casting, grip the main boss in the three-jaw chuck, and face the outside: the boss on this face should project about 3/64 in., so that the shrouding will be about 1/64 in. thicker than on the change-speed gears.

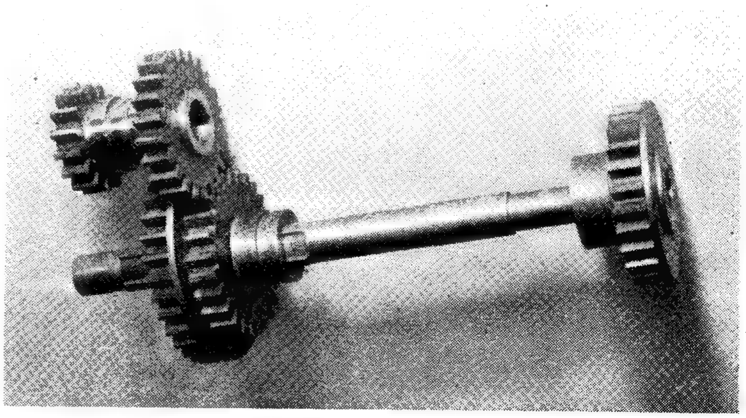
Centre the end, and drill right through, finishing up with the 11/32-in. drill. Then, with a slim boring tool, bore out until the leading end of a $\frac{3}{8}$-in. reamer will just enter the hole. Finish the bore by reaming.

It is now necessary to cut a 3/32 in. wide keyway in the bore; this is done as before, but the shank of the slotting tool will have to be made from $\frac{5}{16}$ in. dia. silver-steel instead of $\frac{3}{8}$ in. You will be able to use the same tool-bit as in the last keyway job, of course.

When the keyway is cut, the casting may be mounted on a stub mandrel in the chuck, or on a mandrel between centres, so as to ensure the boss being turned concentric with the bore. The part of the boss which fits the bore of the pinion should be an interference fit as with the other gears, and the inner end—that is, the outer end as now mounted in the lathe—is only $\frac{7}{8}$ in. in diameter, to allow the pinion easily to pass over it. When the machining is finished, remove the mandrel and press home the pinion as before. Don't forget to remove the inner arris on its bore, by the way.

This week's photograph shows the second shaft with the change-speed gear-wheels mounted in position. The change-speed pinions are mounted on their centre, but the shrouds

(*Continued on page* 602)



Photograph No. 34. Change-speed gears of the Allchin "M.E." traction engine, with fast speed engaged. See text for further details

Cemented joints in leather belts

By "Duplex"

THE endless V-belt has largely replaced flat and round leather belting for driving machine tools in the small workshop ; nevertheless, a round belt is generally needed where the drive has to be taken round jockey pulleys. Making a satisfactory and durable joint in a round belt has always been rather a problem, ever since the days when the customary drive for the amateur's lathe consisted of a round gut belt fitted with a detachable hook and eye fastener. Older readers will remember the monotonous "click-click !" as the belt fastener struck the mandrel pulley. The U-shaped, steel-wire fastener is now commonly fitted, but this, too, has its disadvantages, as it weakens the belt and is liable to pull through or tear the leather.

If the U-fastener is fitted so that the two ends of the belt are butted closely together, a stiff place is formed in the belt, and this is very noticeable as the belt travels round a small pulley.

On the other hand, if a gap is left between the ends of the belt, the leather can work on the fastener and wear may be rapid.

Clearly, the most satisfactory solution is to emulate the most valuable quality of the V-belt and make the round belt as nearly as possible endless. For this purpose, a cemented joint appears to have many advantages, for it is flexible and does not lack strength or good wearing qualities. Moreover, this does not distort the belt, and a well-made joint may be quite difficult to detect.

Making the Cemented Joint

In the first place, the two ends of the belt must be accurately scarfed so that, after the joint is made, the belt will be straight, and of uniform thickness throughout.

To give the necessary strength to the joint, the length of the scarfing should be equal to some six times the diameter of the belt itself. This scarfing can, of course, be done free-hand with a knife or chisel, and some, no doubt, will prefer to do it this way ; but if the belt has been cut to the finished length, any mistake made when scarfing may spoil a length of belting for the job in hand.

Scarfing the Ends of the Belt

To make sure of doing the work correctly, the small planing block and plane illustrated were made from scap ends of material. The block (*A*), Fig. 3, was made from a length of mild-steel ; this was gripped in the lathe toolpost so that the end could be milled flat and at an angle of 10 deg. with the long axis. After drilling the end with a centre-drill, the passage for the belt was drilled out at the same setting to the finished size. As a result of careful feeding, the drill did not wander after the point had broken through ; but if there is any doubt on this score, it is advisable either to clamp an additional steel strip to the work to guide the drill, or to use a larger piece of material and then cut away the unwanted portion. The small plane (*B*) is built up in the way shown in Fig. 4. The base is fitted with two guide strips (*C*) or, if preferred, the part can be milled to shape from the solid. A spring-steel plate (*D*) is fitted for holding the blade in place.

A safety-razor blade is used for the plane iron ; that fitted is an "Ever Ready" blade, which has a stiffener at the back, but the ordinary "Autostrop" type of blade will serve equally well if the spring plate is modified to afford a secure hold.

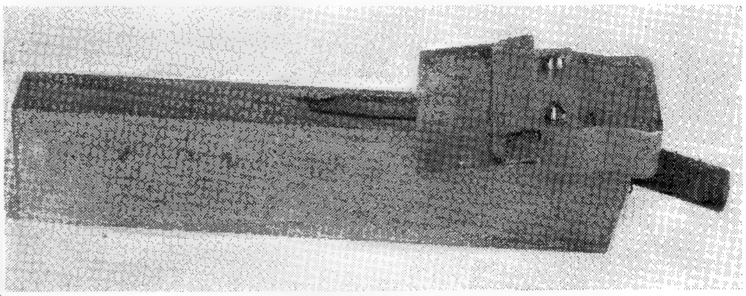


Fig. 2. The planing block and plane

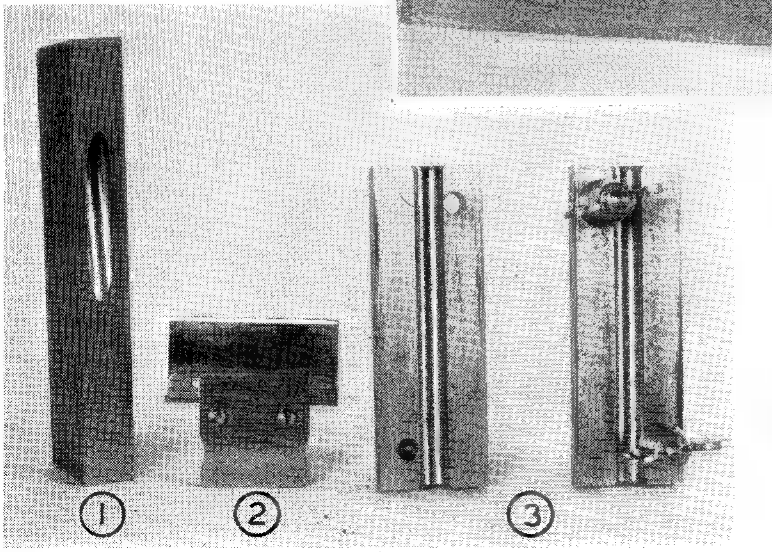


Fig. 1. The belt-jointing equipment. 1—the planing block; 2—the plane; 3—the upper and lower plates of the belt clamp

The two ends of the belt can now be held, in turn, in the block and the plane worked to and fro until evenly scarfed surfaces are obtained, but towards the finish it is advisable to take only a light cut.

Applying the Belt Cement

The cement used was obtained from Messrs. Fenner, the belt manufacturers. Before applying the cement, the cut surfaces of the belt should be roughened with a wire brush in order to increase the area of contact and form a key for the cement. At the same time, any excess of oily belt dressing should be removed either with petrol or acetone.

The cement is applied with a stiff bristle brush, and worked well into both ends of the belt. This first coating is allowed to dry for a period of some twenty minutes and, after a second coating has been applied, the ends of the belt are at once pressed firmly together so as to expel any air from between the joint surfaces.

A Belt Clamp

As it is important to maintain pressure on the joint for at least fifteen minutes, and to ensure that the two ends of the belt are kept evenly applied and correctly in line, a special clamp, Fig. 5, was made for this purpose. Two lengths of $\frac{1}{4}$ in. × 1 in. steel bar, separated by a thin metal strip, were gripped in the 6 in. four-jaw chuck, and a passage for the belt was drilled from end to end. If a smaller chuck than this, with shorter jaws, is used, it may be found necessary to apply a toolmaker's clamp to the end of the work in order to keep the two bars from spreading.

The studs and wing-nuts shown in the drawing are next fitted.

When the belt is clamped in place after cementing, the narrow gap between the upper and lower plates allows air to enter and promote drying of the cement.

The belt should not be compressed too tightly in the clamp, as this may express the belt dressing, and so interfere with the firm sealing of the joint. The belt can be removed from the clamp after a quarter of an hour, but no tension should be applied to the belt for at least twelve hours.

Stitching the Joint

Although a joint made in this way may be regarded as fully strong, it sometimes happens that, when the belt is acutely flexed by running on a very small pulley, the ends of the scarfed joint tend to open. This

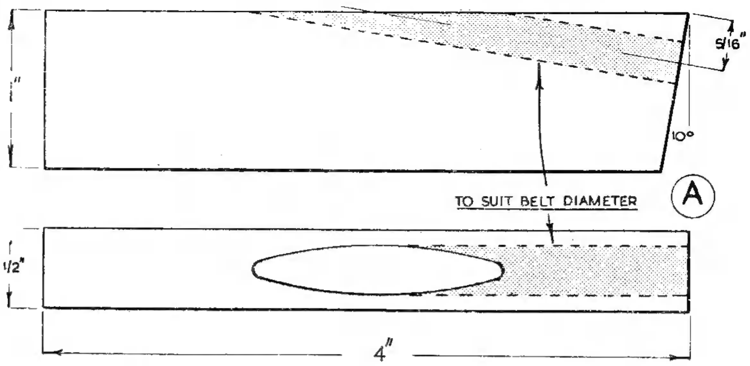


Fig. 3. Details of the planing block

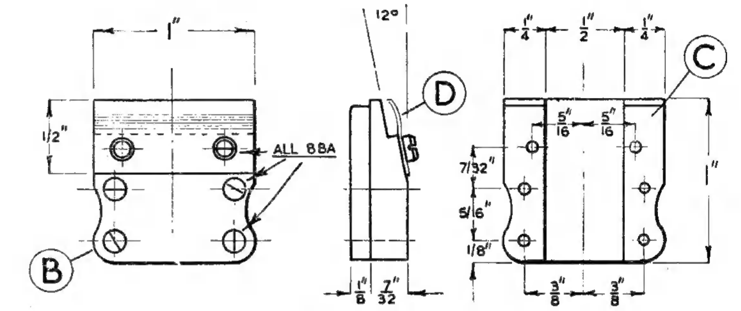


Fig. 4. B—the plane ; C—the guide strips ; D—the blade spring-holder

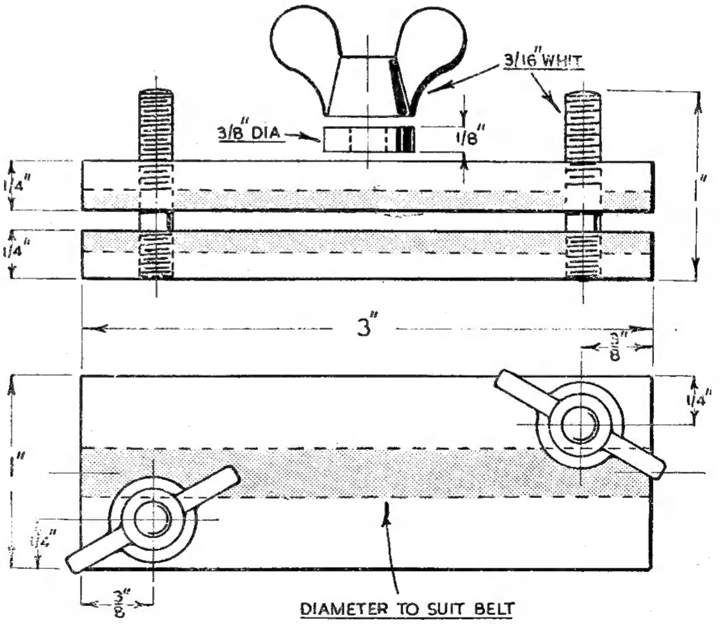


Fig. 6. Details of the belt clamp

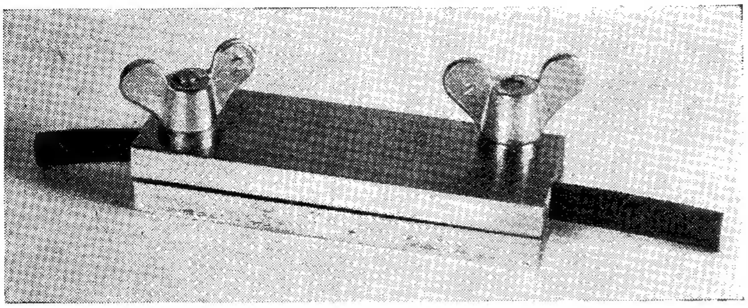


Fig. 5. The cementing clamp with the belt in place

can be avoided by stitching the joint, and we have had a cemented and stiched belt running on small pulleys for a period of ten years without needing attention. One method of stitching is that illustrated in Fig. 7.

The stitch holes are first pierced with an awl, or they can be drilled ; but, to avoid weakening the belt, the holes should be kept as small as possible. A single thread is used, carrying a needle at either end, so that the stitching is continuous on both sides and the thread crosses within the belt. The stitching should extend well beyond the end of the joint and, at the finish, the two ends of the thread are knotted together. To seal the thread, a thin coating of belt cement is finally applied to the stitching.

Cementing Flat Belts

The joints in flat belts are cemented in the same way as those in round belts, but the scarfed ends are rather more easily cut to shape. One way of scarfing the end of a flat belt is to fix it to a board with a clamp or a couple of small tacks and then to use a smoothing plane for shaping the leather. After the ends of the belt have been given a double coating of cement, they are pressed together correctly in line, and the joint is then clamped between two strips of metal in the vice, or the necessary pressure can be applied by means of a pair of clamps. When the joint is dry, any surface irregularities or excess of cement can be removed by rubbing with fine glass-paper.

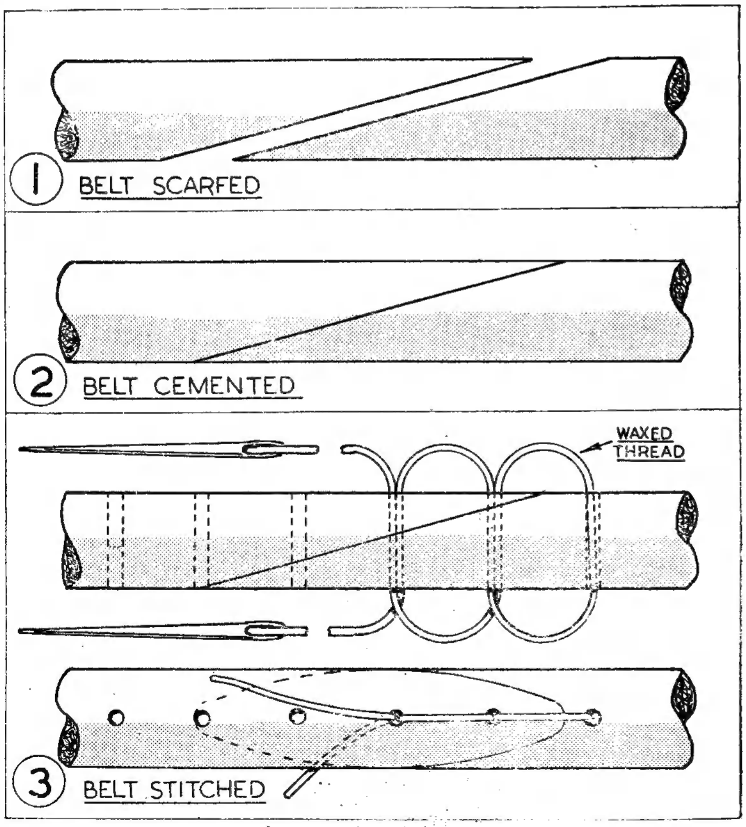


Fig. 7. The stages in jointing the belt, showing the method of stitching the joint

The Allchin "M.E." Traction Engine

(*Continued from page* 599)

have not yet been fitted. On the outer end of the shaft, the second motion pinion is ready to be pressed home, but, of course, this will not be done for some time yet, until final assembly.

Incidentally, for photographically-minded readers, my camera is an Ensign Selfix 16-20 (No. 2 model), and for close-up work I use either the Proxavis I or Proxavis II supplementary lens, according to distance. The film used is Ilford HP3, and illumination is by one or sometimes two ordinary Photoflood No. 1 bulbs. Normally the stop is f.16, but sometimes f.22 is used. Exposures vary between a half and two seconds. I have no connection with any of the firms named, but must say that as a mere amateur in the photographic field I am very satisfied with the results given by the combination of their wares.

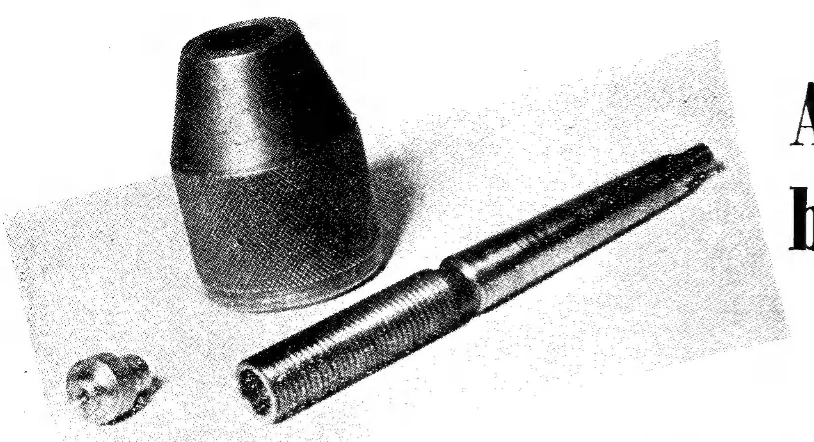
Collar for the Second Shaft

To keep the second shaft in place, a collar is fitted inside the right-hand bearing. Its dimensions are given in the drawing, and it is turned from mild-steel. I do not think detailed machining instructions are necessary, but the 3/32 in. hole for the securing pin should not be drilled at present. Leave it until final assembly, when the hole can be drilled right through the collar and shaft together. Oh yes, and don't make the bore too tight a fit on the shaft : it should be possible to slide it on by hard pressure with the fingers.

(*To be continued*)

An inserted back centre

By L. C. Mason



The main components of tailstock drill-chuck, with centre insert to fit arbor

A SMALL turning job was recently required on a very slender piece, when time was of some importance. Its length required the tail to be supported by the back centre, but a diameter of only 3/32 in. was too small to permit drilling the normal centre with the smallest centre drill available.

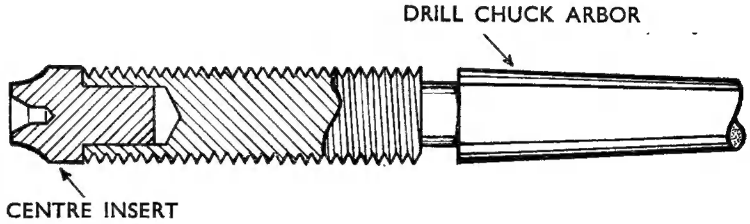
The answer was obviously a female back centre, but the workshop doesn't possess one. At least, it didn't—it does now. Another thing it couldn't provide at the time, was a length of silver-steel large or long enough from which to turn one up to fit the No. 1 Morse taper tailstock socket. Producing nicely fitting tapers is not a job which should be hurried, anyway.

The tailstock drill chuck suggested possibilities, but it was thought desirable to try to produce a centre with somewhat less overhang than one held in the drill chuck would give, and also to work out something that could be held a bit more stiffly so far as side thrust went. The drill chuck was the solution, as it happened, but via a small attachment for it. We seemed to remember that in this particular chuck the jaws were pushed forward by a hardened floating pad, having a round stem locating in the drilled end of the chuck arbor. Running the arbor out of the chuck body confirmed that this was the case. Here then, was the main part of the centre ready made.

A small piece of ½ in. round silver-steel was chucked in the three-jaw and faced both ends. It was then turned down for a length equal to the stem of the drill chuck pad to a diameter that left it a stiffish push fit in the drilled end of the arbor. A centre-punch mark on the end of the arbor and the plug ensured that they could always be replaced in the same position relative to each other, and that the arbor could be placed in the tailstock socket in future nearly enough in the same position.

A small centre drill was then set to run quite truly in the four-jaw, the arbor complete with plug inserted in the tailstock, and a neat centre drilled in the face of the plug. The arbor was then transferred to the mandrel socket, and the outer corners of the plug chamfered back generously for tool clearance.

All that remained was to remove it from the arbor, harden it out and clean up—the result being an accurate, hardened "centre-insert."



"HANGING" THE MOTOR

At a very progressive laundry in a Midlands town, it was found that both engine and boiler were becoming overloaded and it was decided that the best way out of the difficulty was to introduce electric power to share the load. The question then arose as to the place and position of the new motor.

Floor space was at once ruled out, as the motor was a rather attractive-looking machine.

The Borough Electrical Engineer suggested fixing it on two wall brackets, but the proprietor was in favour of bolting direct to the wall, and finally the maintenance engineer was asked for his views on the matter.

Now it should be pointed out that there were several factors to be considered. The ceiling of the room where the motor was to be fixed was stained and varnished, and the outside roof was of concrete, and flat. The end covers of the motor could be used in four positions to suit oiling arrangements. There were no slide rails attached to the motor. These items had been carefully considered by the maintenance engineer, and on the next discussion he suggested *hanging* the motor from the ceiling.

Having eventually got permission to "have his own way" the maintenance engineer marked the bolt holes on the ceiling. The concrete roof was next drilled, and the four bolts made by screwing each end of round stock material. The armature was next removed to reduce the weight. Two bolts were then inserted in the bolt holes at cross corners.

Two ropes were then lowered through the remaining holes and attached to the body of the motor (this, of course, being upside-down). At a given signal, two men, one on each rope, were able to raise the motor body to the ceiling, then securing it by the two hanging bolts.

The armature was then replaced, the starter was fixed in a convenient position on the nearest wall, and the general appearance and handiness well repaid the little extra labour involved. P. ROBINSON.

QUERIES AND REPLIES

"THE M.E." FREE ADVICE SERVICE. Queries from readers on matters connected with model engineering are replied to by post as promptly as possible. If considered of general interest the query and reply may also be published on this page. The following rules must, however, be complied with:

(1) Queries must be of a practical nature on subjects within the scope of this journal.
(2) Only queries which admit of a reasonably brief reply can be dealt with.
(3) Queries should not be sent under the same cover as any other communication.
(4) Queries involving the buying, selling, or valuation of models or equipment, or hypothetical queries such as examination questions, cannot be answered.
(5) A stamped addressed envelope must accompany each query.
(6) Envelopes must be marked "Query" and be addressed to THE MODEL ENGINEER, 19-20, Noel Street, London, W.1.

Passenger-Hauling Electric Locomotive

I wish to build an electric locomotive for hauling children at fetes, etc., and have been looking for a suitable type of motor to use for the job.

(1) *Would a 12-volt car starter motor, suitably geared down, be powerful enough to haul a driver and three children?*

(2) *It is proposed to supply current by means of a petrol engine-driven generator producing 300 watts at 12 volts and feeding the current to the locomotive through the track. Is it necessary to use a storage battery or could the current be supplied direct from the generator? Would there be voltage drop due to the resistance of the rail, which is 100 ft. long?*

(3) *In the event of a car starter being unsuitable, can you suggest any other 12-volt motor that would be suitable, such as ex-Government surplus or standard commercial motor?*

(4) *Do you know of anyone who has experimented along these lines, and what results have been obtained?*

(5) *In the event of this scheme being practical, what is the most suitable output for the generator, and what should be the voltage and amperage, also the capacity of the battery if required?*

R.G.W. (Rye).

(1) A car starter motor would be quite suitable for the purpose of driving a model railway system, though the motor will be much larger than is necessary for this purpose. A starter motor is designed to give a high horse power for a short period of time, and may develop as much as 3 h.p. A $\frac{1}{8}$ to $\frac{1}{4}$ h.p. motor would be better. A suitable motor taking a current of up to say 12 amps on load can be used, and it is possible to find something in this line on the surplus market.

(2) So far as the power unit is concerned, a battery is not necessarily required. If the generator is suitably compounded, it will be suitable for the sudden current demand at starting the motor. A plain shunt machine may not be suitable, as there is likely to be a very large voltage drop when a sudden heavy load is called for. If your generator is a shunt machine, the better plan would be to use a battery of half the normal output capacity, and run the battery and generator in parallel when working the train.

(3) Depending upon the bonding of the rail system, the resistance of the track may be good or bad; if good, the voltage drop will be reasonable. In real practice it is usual to feed the track at intervals along its length; you could do this by providing feeder cables at, say, three equal points along the track. If the rail bonding is perfect, it will only be necessary to feed the collector rail at these points. We do not know of any similar scheme at present in operation, but see no season why it should not be successful.

(4) A generator of approximately 300 watts output would be ample, and a standard car battery would be suitable to use with it, if this is considered necessary.

Engine for Boat

I have been using a 5 c.c. compression-ignition engine for boat propulsion, but find it unsatisfactory for this purpose, as it will run only on full throttle. I require an engine which will run on any throttle setting from tick-over to full power.

Please inform me if this must be a four-stroke engine, or whether a two-stroke engine would answer my purpose.

Can I convert my c.i. engine to run on petrol by removing the contra-piston and fitting sparking-plug, contact-breaker coil, etc., or must I procure a two-stroke engine specially designed for petrol?

S.B.W. (Horsley).

It should be possible to convert your engine to a petrol engine by modifying the cylinder-head, and fitting a contact-breaker, and we are fairly certain that in this way the flexibility could be greatly improved.

A four-stroke engine is definitely more flexible than a two-stroke, and we suggest that as you require the engine for boat propulsion, a suitable engine would be the single-cylinder version of the Seagull engine, which is known as the "Seamew." Castings for this can be obtained from Craftsmanship Models Ltd., Norfolk Road Works, Ipswich, and we may mention that they can also supply castings for the "Cadet" 5 c.c. two-stroke engine, which is a successor to the "Kestrel" engine, but very much improved in design. Incidentally, for any type of engine requiring a wide range of flexibility, the simpler types of carburettors have very severe limitations, but an automatic or semi-automatic carburettor, such as that designed for the "Phoenix" 15 c.c. engine, would enable full control to be obtained.

Aluminium Castings

I wish to make some small castings in aluminium, and shall be glad of any information you can give me on melting this metal. Is it possible to use aluminium alloy for these castings, and if so, can it be melted in the same clay crucible as pure aluminium?

B.G.R. (Dewsbury).

Aluminium or its alloys can be melted in a clay or plumbago crucible, and there are no very special difficulties involved, except to skim away impurities from the surface of the molten metal, and avoid pouring at too high a temperature.

Pure aluminium is not suitable for general purpose castings which have to be machined, as it is soft, and clings to the tool badly in machining. If you are making castings on a small scale, we suggest that you could obtain a suitable alloy from old motor-car pistons, but crankcase metal also makes reasonably good castings when remelted. Some kinds of aluminium alloys, however, lose their special properties when remelted, unless special precautions are taken.

Some useful information on this subject was contained in the articles by Mr. A. L. Headech on "Amateur Foundry Work." These articles appeared in the issues of THE MODEL ENGINEER dated May 25th, June 8th and 15th, 1950. Copies of these issues can be obtained from our publishing department, price 9d. each.